THE

PHILOSOPHICAL MAGAZINE:

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,

THE LIBERAL AND FINE ARTS,

GEOLOGY, AGRICULTURE,

MANUFACTURES AND COMMERCE.

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"Nec araneârum sane textus ideo melior quia ex se fila gignunt, nec noster vilior quia ex alienis libamus ut apes." JUST. LIPS. *Monit. Polit.* lib. i. cap. 1.

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I. *A Synopsis of the principal Elements of Astronomy; deduced from* M. LAPLACE'S *Exposition du Système du Monde. Communicated by* FRANCIS BAILY, *Esq.*

THE following paper possesses no further merit than as being a faithful abstract of the principles and facts given by M. Laplace in his *Exposition du Système du Monde*. It is taken from the *third* edition of that work (1808), wherein the author has given the elements of the planets in a more correct manner than in either of the preceding editions; and wherein he has revised and amended all his former calculations by more recent and exact observations.

The arrangement of the present memoir is somewhat new: but many persons have frequently found the want of a manual of this kind, where all the different *facts*, relative to astronomy, might be brought under their respective heads, without the necessity of turning to a variety of works for information. Much time is often lost in a research of that kind, which it is the object of the present abstract to prevent.

In the original work, the author has universally adopted the *decimal* division of the day, and of the quadrant. This method is here preserved in the Tables of the Elements of the Planets (page 6): but, in the subsequent parts, the common *sexagesimal* notation is adopted, as being more easily understood in this country.

Some other facts, not mentioned by M. Laplace, are inserted in this tract, in order to enlarge the view of the subject: but these passages are always kept separate, by being inclosed within brackets.

The Sun.

The Sun, which is the source of light and heat to our system, is the most considerable of all the heavenly bodies; and governs all the planetary motions.

Its *diameter* is 111·454 times the mean diameter of the Earth: whence its *volume* is 1384472 times greater than that of the Earth: but its *mass* is only 337086 times greater. Whence we conclude that its *density* is $\frac{1}{3·93326}$, or about $\frac{1}{4}$ that of our globe.

It is surrounded by an *atmosphere*: and it is oftentimes covered with *spots*. Some of these spots have been observed so large as to exceed the Earth 4 or 5 times in magnitude.

The observation of these spots shows that the Sun moves on its *axis*, which is nearly perpendicular to the ecliptic; and the duration of an entire sidereal rotation of the Sun is about $25\frac{1}{2}$ days.

Whence we conclude that the Sun is *flattened* at the poles.

The solar equator is *inclined* 7° 30′ to the plane of the ecliptic.

A body, which weighs one pound at the surface of the Earth, would, if removed to the surface of the Sun, weigh 27·933 pounds. And bodies would fall there with a velocity of 334·65 feet in the first second of time.

The Sun, together with the planets, moves round the common centre of gravity of the system: which centre is nearly in the centre of the Sun.

This motion changes into epicycloïds the ellipses of the planets and comets, which revolve round the Sun.

The Sun appears to have a particular motion, which carries our system towards the constellation of Hercules.

The *apparent diameter* of the Sun, as seen from the Earth, undergoes a periodical variation. It is greatest when the Earth is in its perihelion; at which time it is 32′ 35″,6: and it is least when the Earth is in its aphelion; at which time it is 31′ 31′,0. Its mean apparent diameter is therefore 32′ 3″,3.

His horizontal *parallax* is $8\frac{3}{4}$″.

The greatest *equation of his centre* is 1° 55′ 27″,7; which diminishes at the rate of 16″,9 in a century.

The *diurnal* motion of the Sun from east to west, and his *annual* motion in the ecliptic, are optical deceptions; arising from the real motion of the Earth on its axis, and in its orbit.

The

The Planets.

The number of planets belonging to our system is eleven. Six of these have been known and recognised from time immemorial: namely, Mercury, Venus, the Earth, Mars, Jupiter, and Saturn. But the remaining five, which are not visible to the naked eye, have lately been discovered by the help of the telescope; and are therefore called *telescopic planets:* namely,

Uranus, discovered by	Dr. Herschel,	March 13, 1781.
Ceres, ...	M. Piazzi, . .	January 1, 1801.
Pallas, ...	M. Olbers, . .	March 28, 1802.
Juno, ...	M. Harding,	Septem. 1, 1803.
Vesta, ...	M. Olbers, . .	March 29, 1807.

All these planets revolve round the Sun, as the centre of motion: and in performing their revolutions they follow the fundamental laws of the planetary motion so happily discovered by Kepler; and which have been fully confirmed by subsequent observations. These laws are,

I. *The orbit of each planet is an ellipse; of which the Sun occupies one of the foci.*

The extremity of the major axis of this ellipse, nearest the Sun, is called the *perihelion:* the opposite extremity of the same axis is called the *aphelion.* The line, which joins these two points, is called the line of the *apsides.* The *radius vector* is an imaginary line drawn from the centre of the Sun to the centre of the planet, in any part of its orbit.

The *velocity* of a planet in its orbit is always greatest at its perihelion. This velocity diminishes as the radius vector increases; till the planet arrives at its aphelion, when its motion is the slowest. It then increases, in an inverse manner, till the planet arrives again at its perihelion.

II. *The areas, described about the Sun by the radius vector of the planet, are proportional to the times employed in describing them.*

These laws are sufficient for determining the motion of the planets round the Sun: but it is necessary to know, for each of these planets, seven quantities; which are called *the elements of their elliptical motion.* The first five of these elements relate to the motion in an ellipse: the last two relate to the position of the orbit; since the planets do not all move in the same plane.

1. The duration of a sidereal revolution of the planet.

2. Half the major axis of the orbit; or the mean distance of the planet from the Sun.

3. The eccentricity of the orbit; whence we deduce the greatest equation of the centre.

 4. The

4. The mean longitude of the planet at a given epoch.
5. The longitude of the perihelion at a given epoch.
6. The longitude of the nodes at a given epoch.
7. The inclination of the orbit to the ecliptic.

The following tables present all these elements for the first moment of the present century: namely, for that point of time at midnight which separates the 31st of December 1800, and the 1st of January 1801; mean time at *Paris*. [The observatory at Paris is in north latitude 48° 50′ 14″, and in longitude 9′ 21″ east from Greenwich observatory.]

1. *Duration of a Sidereal Revolution.*

	days.		days.
Mercury..	87·96925804	*Ceres*....	1681·53900000
Venus....	224·70082399	*Pallas*...	1681·70900000
Earth	365·25638350	Jupiter ..	4332·59630760
Mars	686·97961860	Saturn ..	10758·96984000
Vesta	1335·20500000	*Uranus* ..	30688·71268720
Juno	1590·99800000		

2. *Mean Distance from the Sun.*

Mercury....	·3870981	*Ceres*......	2·7674060
Venus......	·7233323	*Pallas*	2·7675920
Earth	1·0000000	Jupiter	5·2027911
Mars	1·5236935	Saturn	9·5387705
Vesta	2·3730000	*Uranus*	19·1833050
Juno	2·6671630		

3. *Ratio of the Eccentricity to half the Major Axis.*

Mercury....	·20551494	*Ceres*......	·07834860
Venus......	·00685298	*Pallas*	·24538400
Earth	·01685318	Jupiter....	·04817840
Mars	·09313400	Saturn	·05616830
Vesta......	·09322000	*Uranus*....	·04667030
Juno	·25494400		

4. *Mean Longitude January* 1, 1801.

Mercury	182° 15647	*Ceres*......	294° 16820
Venus......	11° 93672	*Pallas*	280° 68580
Earth	111° 28179	Jupiter	124° 67781
Mars	71° 24145	Saturn	150° 38010
Vesta......	297° 12990	*Uranus*	197° 54244
Juno	322° 79380		

5. *Mean Longitude of the Perihelion.*

Mercury......	82° 6256	*Ceres*........	162° 9565
Venus........	142° 9077	*Pallas*	134° 7040
Earth	110° 5571	Jupiter	12° 3812
Mars	369° 3407	Saturn	99° 0549
Vesta........	277° 4630	*Uranus*......	185° 9574
Juno	59° 2349		

6. *Longitude of the ascending Node.*

Mercury	51° 0651	*Ceres*	89° 9083
Venus.........	83° 1972	*Pallas*......	191° 7148
Earth	0° 0000	Jupiter	109° 3624
Mars	53° 3605	Saturn	124° 3662
Vesta	114° 4630	*Uranus*	80° 9488
Juno	190° 1228		

7. *Inclination of the Orbit to the Ecliptic.*

Mercury......	7° 78058	*Ceres*	11° 80680
Venus........	3° 76936	*Pallas*	38° 46540
Earth	0° 00000	Jupiter	1° 46034
Mars	2° 05663	Saturn	2° 77102
Vesta	7° 94010	*Uranus*	0° 85990
Juno	14° 50860		

The examination of the first two tables here given will show us that the duration of the revolutions of the planets increases with their mean distance from the Sun. Whence Kepler discovered his third fundamental law: namely,

III. *The squares of the times of the revolutions of the planets are to each other as the cubes of their mean distances.*

The ellipses, which the planets describe, however, are not unalterable. Their major axes appear to be always the same: but their eccentricities, the positions of their perihelion and nodes, together with the inclination of their orbits to the ecliptic, seem to vary in a course of years. These variations, being sensible only in a series of ages, are called *secular inequalities*. There is no doubt of their existence: but the modern observations not being sufficiently extensive, and the ancient not sufficiently exact, there still rests some degree of uncertainty as to their magnitude. The following table will show the inequalities that happen in a period of one hundred years, and are the values that appear to accord best with the present observations.

SECULAR INEQUALITIES OF THE PLANETS.

The sign — signifies a Diminution.

Planets.	In the Eccentricity.	In the Perihelion.	In the Inclination.	In the Place of Nodes.
Mercury	·000003867	0° 180110	0° 005612	—0° 241441
Venus ..	—·000062711	—0° 082663	—0° 001405	—0° 577099
Earth ...	—·000041632	0° 364140	....	....
Mars....	·000090176	0° 488405	—0° 000447	—0° 718665
Jupiter ..	·000159350	0° 204895	—0° 006978	—0° 486904
Saturn ..	—·000312402	0° 597860	—0° 004788	—0° 699525
Uranus ..	—·000025072	0° 073869	0° 000967	—1° 110481

 There

There are also some inequalities which affect the *elliptical motion* of the planets. That of the Earth is a little altered. But they are most sensible in Jupiter and Saturn: for it appears that the duration of their revolution round the Sun is subject to a periodical variation.

Mercury.

Mercury is the nearest planet to the Sun: its *mean distance* being ·387, that of the Earth being considered as unity. This makes his mean distance above 36 millions of miles.

He performs his *sidereal revolution* in $87^d\ 23^h\ 15'\ 43'',9$ and his mean synodical revolution in about 116 days.

The *eccentricity* of his orbit is ·2055; half the major axis being taken equal to unity.

His *mean longitude,* at the commencement of the present century, was in $5^s\ 23°\ 56'\ 27'',0$.

The longitude of his *perihelion* was, at the same time, in $2^s\ 14°\ 21'\ 46'',9$. The line of the apsides has a sidereal motion, according to the order of the signs, equal to $9'\ 43'',6$ in a century. But, if referred to the ecliptic, this motion will (owing to the precession of the equinoctial points) be equal to $55'',8$ in a year; or to $1°\ 33'\ 13'',6$ in a century.

His orbit is *inclined* to the plane of the ecliptic in an angle of $7°\ 0'\ 9'',1$: which angle is subject to a small increase of about $18'',2$ in a century.

His orbit, at the commencement of the present century, crossed the ecliptic in $1^s\ 15°\ 57'\ 30'',9$: having a sidereal motion, to the westward every century, of $13'\ 2'',2$. But, if referred to the ecliptic, the place of the *nodes* will (on account of the precession of the equinoxes) fall more to the eastward by $42'',3$ in a year, or $1°\ 10'\ 27'',8$ in a century.

The *rotation* on his axis is accomplished in $1^d\ 0^h\ 5'\ 28'',3$. But the *inclination of its axis* is not known.

[The *diameter* of Mercury is about 3123 miles: which, compared with the Earth's diameter considered as unity, is about ·3941.]

His *mass*, compared with that of the Sun considered as unity, is $\frac{1}{2025810}$.

[The proportion of *light* and *heat* received from the Sun is about 6·68 times greater than on our planet.]

As seen from the Earth, Mercury never appears at any great distance from the Sun; either in the morning or the evening. His *elongation,* or angular distance, varies from 16° 12′ to 28° 48′.

His course sometimes appears *retrograde*. The mean arc, which it describes in this case, is about 13° 30′; and its

its mean duration is about 23 days: but there is great difference in this respect. This retrogradation commences or finishes when he is about 18° distant from the Sun.

Mercury changes his phases, like the Moon, according to his various positions with regard to the Earth and Sun: but this cannot be discovered without the aid of a telescope. His mean *apparent diameter* is 6″,9.

[Mercury is sometimes seen to pass over the Sun's disk: which can only happen when he is in his nodes, and when the Earth is in the same longitude. Consequently this phænomenon can take place only in the months of May or November. The first observation of this kind was made by Gassendi in November 1631: since which period they have been frequent. The next appearance of this kind will be in November 1815.]

Venus.

Venus performs her *sidereal revolution* in $224^d\ 16^h\ 49'\ 11'',2$: and her mean synodical revolution in about 584 days.

Her *mean distance* from the Sun is ·723; that of the Earth being considered as unity. This makes her mean distance nearly 68 millions of miles.

The *eccentricity* of her orbit is ·0069; half the major axis being considered as unity. She is the least eccentric of all the planets.

Her *mean longitude*, at the commencement of the present century, was in $0^s\ 10^\circ\ 44'\ 35'',0$.

The longitude of her *perihelion* was, at the same time, in $4^s\ 8^\circ\ 37'\ 0'',9$. The line of her apsides has a sidereal motion, contrary to the order of the signs, of 4′ 27,″8 in a century. But, if referred to the ecliptic, this motion will appear (on account of the precession of the equinoxes) to proceed according to the order of the signs at the rate of 47″,4 in a year, or 1° 19′ 2″,2 in a century.

Her orbit is *inclined* to the plane of the ecliptic in an angle of 3° 23′ 32″,7: which angle decreases about 4″,6 in a century.

Her orbit, at the commencement of the present century, crossed the ecliptic in $2^s\ 14^\circ\ 52'\ 38'',9$. But the *nodes* have an apparent motion in longitude of 31″,4 in a year, or 52′ 20″,2 in a century.

The *rotation* on her axis is performed in $23^h\ 21'\ 7'',2$: but the inclination of her *axis* is not known.

[The *diameter* of Venus is 7702 miles: consequently she is nearly as large as the Earth.]

Her

Her *mass*, compared with that of the Sun considered as unity, is $\frac{1}{356632}$.

[The proportion of *light* and *heat*, received by her from the Sun, is 1·91 times greater than on our planet.]

It is surrounded by an *atmosphere*, the refractive powers of which differ very little from those of our atmosphere.

As viewed from the Earth, Venus is the most brilliant of all the planets; and may sometimes be seen with the naked eye, at noon day. She is known as the morning and evening star; and never recedes far from the Sun. Her *elongation*, or angular distance, varies from 45° to 48°.

Her motion sometimes appears *retrograde*. The mean arc, which she describes in such case, is about 16° 12′; and her mean duration is about 42 days. This retrogradation commences, or finishes, when she is about 28° 48′ distant from the Sun.

Venus changes her *phases*, like the Moon, according to her position with respect to the Sun and the Earth: which causes a very considerable difference in her brilliancy.

Her mean *apparent diameter* is 17″,0; her greatest apparent diameter is about 57″,3.

[Venus is sometimes seen to pass over the Sun's disk: which can happen only when she is in her nodes, and when the Earth is in the same longitude. Consequently it can take place only in the months of June or December. Three of these transits have been already observed: one in 1639, one in June 1761, and one in June 1769. There will not be another till the 8th of December 1874.]

The Earth.

The Earth which we inhabit is also one of the planets that revolve about the Sun. It performs its *sidereal revolution* in $365^d\ 6^h\ 9'\ 11'',5$: but the time employed in going from one tropic to the other is only $365^d\ 5^h\ 48'\ 51'',6$. The tropical year is about 11″,2 shorter than it was at the time of Hipparchus.

Its *mean distance* from the Sun is 23578 times its own semi-diameter: whence it is above 93 millions of miles distant from that luminary. If this mean distance be taken equal to unity, we shall have its distance at the perihelion equal to ·9832; and its distance at the aphelion equal to 1·0168.

The *eccentricity* of its orbit is ·0168: half the major axis being considered as unity. The major axis, therefore, will be to the minor axis of the orbit, in the proportion of 1 to ·99439.

Its

Its *mean longitude*, at the commencement of the present century, was $3^s\ 10^\circ\ 9'\ 13'',0$.

Its *velocity* varies in different parts of its orbit. Like all the other planets, it is most rapid in its perihelion, and slowest in its aphelion. In the former point it describes an arc of $1^\circ\ 1'\ 9'',9$ in the course of a day; and in the latter point it describes an arc of only $57'\ 11'',5$ in the same period. The mean velocity is $59'\ 10'',7$ each day.

The mean longitude of its *perihelion* at the commencement of the present century was $3^s\ 9^\circ\ 30'\ 5'',0$. But the line of the apsides has a direct sidereal motion of $19'\ 40'',8$ in a century: which, being referred to the ecliptic, will give it a motion (according to the order of the signs) of $1'\ 1',9$ in a year, or $1^\circ\ 43'\ 10'',8$ in a century. A complete revolution round the line of the apsides is called the *anomalistic* year; and is performed in $365^d\ 6^h\ 14'\ 2''$. The perihelion coincided with the vernal equinox about the year 4089 before the Christian æra. It coincided with the summer solstice about the year 1250 after Christ: and will coincide with the autumnal equinox about the year 6483. A complete tropical revolution of the apsides is performed in 20931 years.

The *axis* of the Earth is *inclined* to the plane of the ecliptic in an angle of $23^\circ\ 27'\ 57'',0$: which angle is observed to decrease at the rate of $52'',1$ in a century. But this variation of the angle is confined within certain limits; and cannot exceed $2^\circ\ 42'$.

The annual intersection of the equator with the ecliptic is not always in the same point: but is retrograde, or contrary to the order of the signs. Consequently the equinoxial points appear to move forward on the ecliptic: and whence this phænomenon is called the *precession of the equinoxes*. The quantity of this annual change is $50'',1$; or $1^\circ\ 23'\ 30''$ in a century. A complete revolution is performed in 25868 years.

The *sidereal day*, or the time employed by the Earth in revolving on its axis, is always the same. Its diurnal rotation has not varied, the hundredth part of a second, since the time of Hipparchus. If the mean astronomical, or civil, day be taken equal to 24 hours, the duration of the sidereal day will be $23^h\ 56'\ 4'',1$.

The astronomical, or *civil, day* is constantly changing. This variation arises from two causes: 1. The unequal motion of the Earth in its orbit; 2. The obliquity of that orbit to the plane of the equator. [The mean and apparent solar days are never equal, except when the Sun's daily motion

tion in right ascension is 59′ 8″. This is the case about April 16th, June 16th, September 1st, and December 25th: on these days the difference vanishes, or nearly so. It is at its greatest about November 1st, when it is 16′ 16″.]

The *astronomical year* is divided into four parts, determined by the two equinoxes and the two solstices. The interval between the vernal and autumnal equinoxes is (on account of the eccentricity of the Earth's orbit, and its unequal velocity therein) near eight days longer than the interval between the autumnal and vernal equinoxes. These intervals are, at present, nearly as follow:

	d. h. m.	d. h. m.
From the spring equinox to the summer solstice	..92 21 45	= 185 35 20
From the summer solstice to the autumnal equinox	..93 13 35	
From the autumnal equinox to the winter solstice	..89 16 47	= 178 18 29
From the winter solstice to the spring equinox	..89 1 42	
		7 16 51

The *nutation* of the Earth's axis is 19″,3.

Light takes 8′ 13″,3 to come from the Sun to the Earth. But in this interval the Earth has moved 20″,2 in its orbit. This motion of the Earth produces an optical illusion in the light which comes from the stars: and which Bradley calls the *aberration* of light.

The *figure* of the Earth is that of an oblate spheroïd: the axis of the poles being to the diameter of the equator as 331 to 332. The mean *diameter* of the Earth is about 7916 miles: its equatorial diameter is 7924 miles.

As a necessary consequence from this circumstance, the *degrees of latitude* increase in length as we recede from the equator to the poles. But different meridians, under the same latitude, present different results. The general fact, however, is well ascertained.

The *density* of the Earth is 3·9326 times greater than that of the Sun, and is to that of water as 11 to 2.

Its *mass*, compared with that of the Sun considered as unity, is $\frac{1}{337086}$.

The *centrifugal force* is greater at the equator than at the poles: in consequence of which, bodies lose part of their weight by being taken towards the equator. If the gravity of a body at the equator be represented by unity, its gravity at the poles will be increased by ·00569. A *pendulum*, therefore, which vibrates seconds in the higher latitudes,

latitudes, must be shortened at the equator in order to render the oscillations isochronous. [A pendulum 39·197 inches long will swing seconds at the poles: but, in order that it may swing seconds at the equator, it must be reduced to 39·027 inches.]

The centrifugal force at the equator is nearly $\frac{1}{289}$th of gravity. If the rotation of the Earth were 17 times more rapid, the centrifugal force would be equal to that of gravity: and bodies at the equator would not have any weight.

A rare and elastic fluid surrounds the Earth, which is called the *atmosphere*. Neither the temperature nor density of this fluid is uniform; but diminishes in proportion to its distance from the surface of the Earth, and is also affected by other circumstances.

If the density of the atmosphere were every where the same and its temperature at zero, and the height of the barometer at 29·92196 inches, the height of the atmosphere would be 26067 feet; or 5·7 miles.

The atmosphere is a heterogeneous substance. Out of 100 parts, 79 are azotic gas, and the remaining 21 are oxygen gas. This is found to be universally the case, in whatever season or whatever climate the experiment be tried. This proportion is also found to exist in the highest points of the atmosphere that have been reached by means of balloons.

A body projected horizontally to the distance of about 4·35 miles, if there were no resistance in the atmosphere, would not fall again to the surface of the Earth, but would revolve round it as a satellite; the centrifugal force being then equal to its gravity.

The rays of light do not move in a straight line through the atmosphere; but are inflected continually towards the Earth: so that the stars appear more elevated on the horizon than they really are.

We find, from the most accurate observations, that the refraction, which the atmosphere produces, is independent of its temperature, and proportional to its density. But, as the density varies according to the temperature; it is necessary to attend not only to the state of the barometer, but also of the thermometer.

The humidity of the air produces very little effect on its refractive powers, and may therefore be safely omitted.

The temperature of the whole atmosphere being supposed at zero, its density will diminish in a geometrical progression, according to its distance from the surface of the Earth: and we find by experience that, the height of the

the barometer being 29·92 inches, the refraction at the horizon is 39′ 54″,7. It would be only 30′ 24″,i if its density diminished in arithmetical progression; and would be nothing at the surface. The horizontal refraction, which we observe about 35′ 6″,0, is a mean between these limits.

When the apparent height of a star upon the horizon does not exceed eleven degrees, its sensible refraction depends only on the state of the barometer and thermometer in the place of observation; and it is nearly proportional to the tangent of the apparent distance of the star from the zenith, diminished by $3\frac{1}{4}$ times the corresponding refraction at this distance, the thermometer being considered as at the freezing point and the barometer at 29·92 inches. It is from these principles that have been formed the Tables of Refraction, corresponding to the several variations in the scale of the thermometer and barometer.

The action of the Sun and Moon has a considerable effect on the water of the ocean, and produces the phænomena of the *tides*.

The sea rises and falls twice in each interval of time comprised between the consecutive returns of the Moon to the same meridian. The mean interval of these returns is $1^d\ 0^h$ 50′ 28″,3: consequently the mean interval between two following periods of high water is 12^h 25′ 14″,3. So that the retardation in the time of high water, from one day to another, is 50′ 28″ in its mean state: and it is affected by all those causes which influence the Moon's motion.

This retardation varies with the phases of the Moon. It is at its minimum towards the syzigies when the tides are at their maximum, and it is then only 38′ 57″,1. But, when the tides are at their minimum, or towards the quadratures, it is then the greatest possible; and amounts to 1^h 14′ 58″,8.

The variation in the distances of the Sun and Moon from the Earth (and particularly the Moon) has an influence also on this retardation. Each minute in the increase or diminution of the apparent diameter of the Moon augments or diminishes this retardation 3′ 42″,9 towards the syzigies; but towards the quadratures the effect is three times less.

The daily retardation of the tides varies likewise with the declination of the Sun and Moon. In the *syzigies*, at the time of the solstices, it is about 2′ 13″,9 greater than in its mean state: and it is diminished in the same proportion, at the time of the equinoxes. On the contrary, in the

the *quadratures*, at the time of the equinoxes, it exceeds its mean state by 7′ 49″,2; and is in a similar manner diminished by this quantity, at the time of the solstices.

The *height* of the tides is also considerably influenced by all those causes which have been just mentioned; and depends on the phases and position of the Moon in her orbit. It is greatest when the Moon is in the syzigies; and is diminished in the quadratures. The *distance* likewise of the Sun and Moon from the Earth, as well as their *declination*, has a material effect upon the height of the tides.

But the state of the tides is so modified by the nature and position of the coasts, the depth of the channel, the operation of the winds, and by other causes, that the above laws will not always be found to correspond with the actual state of the tides, particularly near the coast, or in rivers. It will however be found, from the mean of a number of observations, that the inequalities in the heights and in the intervals of the tides have various periods. Some are of half a day and a day; others are of half a month and a month; whilst others again are of half a year and a year: and some are the same as the times of the revolutions of the lunar nodes and apsides.

The action of the Moon upon the waters of the ocean is triple that of the Sun.

Mars.

Mars is easily known in the heavens by his red and fiery appearance. He performs his *sidereal revolution* in 686^d 23^h 30′ 39″,0 or in 1·881 Julian years: and his mean synodical revolution in about 780 days, or in about 2·135 years.

His *mean distance* from the Sun is 1·524; that of the Earth being considered as unity. This makes his mean distance above 142 millions of miles.

The *eccentricity* of his orbit is ·093: half the major axis being considered as unity.

His *mean longitude*, at the commencement of the present century, was in 2^s 4° 7′ 2″,3.

The longitude of his *perihelion* was, at the same time, in 11^s 2° 24′ 23″,9: but the line of the apsides has an apparent motion, according to the order of the signs, of 1′ 5″,9 in a year, or 1° 49′ 52″,4 in a century.

His orbit is *inclined* to the plane of the ecliptic in an angle of 1° 51′ 3″,5: which angle decreases about 1″,4 in a century.

His orbit at the commencement of the present century crossed the ecliptic in 1^s 18° 1′ 28″,0: but the place of the

nodes

nodes has an apparent motion in longitude, according to the order of the signs, of 26″,8 in a year, or 44′ 41″,5 in a century.

The *rotation* on his axis is performed in $1^d\ 0^h\ 39'\ 21'',3$: and his *axis* is inclined to the ecliptic in an angle of 59° 41′ 49″,2.

[His mean *diameter* is equal to 4398 miles: consequently he is rather more than half the size of our Earth.]

His *mass*, compared with that of the Sun considered as unity, is $\frac{1}{2546320}$.

[The proportion of *light* and *heat*, received by him from the Sun, is ·43: that received by the Earth being considered as unity.]

He has a very dense but moderate *atmosphere:* and he is not accompanied by any *satellite.*

As viewed from the Earth, the motion of Mars appears sometimes *retrograde.* The mean arc which he describes in this case is 16° 12′: and its mean duration is about 73 days. This retrogradation commences, or finishes, when the planet is not more than 136° 48′ from the Sun.

Mars changes his *phases* somewhat in the same manner as the Moon does from her first to her third quarter, according to his various positions with respect to the Earth and the Sun: but, he never becomes cornicular, as the Moon does when near her conjunctions. His mean *apparent diameter* is 9″,7: which augments in proportion as the planet approaches its opposition, when it is equal to 29″,2.

His *parallax* is nearly double that of the Sun.

Jupiter.

Jupiter is, next to Venus, the most brilliant of all the planets: whom he sometimes however surpasses in brightness. He performs his *sidereal revolution* in $4332^d\ 14^h$ 18′ 41″,0; or in 11·862 Julian years. But this period is subject to some inequalities. He performs his mean synodical revolution in about 399 days.

His *mean distance* from the Sun is 5·203; that of the Earth being considered as unity. This makes his mean distance above 485 millions of miles.

The *eccentricity* of his orbit is ·0482; half the major axis being considered as unity.

His *mean longitude* at the commencement of the present century was in 3^s 22° 0′ 36″,1.

The longitude of his *perihelion* was, at the same time, in 0^s 11° 8′ 35″,1: but the line of the apsides has an apparent

parent motion, according to the order of the signs, of 56″,7 in a year, or 1° 34′ 33″,8 in a century.

His orbit is *inclined* to the plane of the ecliptic in an angle of 1° 18′ 51″,5: which is observed to decrease nearly 22″,6 in a century.

His orbit, at the commencement of the present century, crossed the ecliptic in 3^s 8° 25′ 34″,2. But the place of the *nodes* has an apparent motion in longitude, according to the order of the signs, of 34″,3 in a year, or 57′ 12″,4 in a century.

The *rotation* on his axis is performed in 9^h 55′ 49″,7: and his *axis* forms an angle of 86° 54′ 30″,0 with the plane of the ecliptic.

[His mean *diameter* is equal to 91522 miles: consequently he is about $11\frac{1}{2}$ times as large as our Earth.] The axis of his poles is to his equatorial diameter as ·9287 to 1, or as 13 to 14.

His *mass*, compared with that of the Sun considered as unity, is $\frac{1}{1067 \cdot 09}$: but his *density* is ·909501.

[The proportion of *light* and *heat*, received from the Sun, is ·037: that received by the Earth being considered as unity.]

He is surrounded by faint substances called zones or *belts*; which are supposed to be parts of his atmosphere. And he is accompanied by four *satellites*.

A body, which weighs one pound at the equatorial surface of the Earth, would, if removed to the surface of Jupiter, weigh 2·281 pounds.

As seen from the Earth, the motion of Jupiter appears sometimes to be *retrograde*. The mean arc which he describes in this case is about 9° 54′: and its mean duration is about 121 days. This retrogradation commences, or finishes, when the planet is not more distant than 115° 12′ from the Sun.

His mean *apparent equatorial diameter* is 38″2: it is greatest when in opposition, at which time it is equal to 47″,6.

Saturn.

Saturn performs his *sidereal revolution* in 10758^d 23^h 16′ 34″,2; or in 29·456 Julian years. But this period is subject to some inequalities. His mean synodical revolution is performed in about 378 days.

His *mean distance* from the Sun is 9·539; that of the Earth being considered as unity. This makes his mean distance above 890 millions of miles.

The *eccentricity* of his orbit is ·0562; half the major axis being taken as unity.

His *mean longitude* at the commencement of the present century, was in 4^s 15° 20′ 31″,5.

The longitude of his *perihelion* was, at the same time, in 2^s 29° 8′ 57″,9: but the line of the apsides has an apparent motion in longitude, according to the order of the signs, of 1′ 9″,5 in a year, or 1° 55′ 47″,1 in a century.

His orbit is *inclined* to the plane of the ecliptic in an angle of 2° 29′ 38″,1: which is observed to decrease about 15″,5 in a century.

His orbit, at the commencement of the present century, crossed the ecliptic in 3^s 21° 55′ 46″,5: but the place of the *nodes* has an apparent motion in longitude, according to the order of the signs, of 27″,4 in a year, or 45′ 43″,5 in a century.

The *rotation* on his axis is performed in 10^h 16′ 19″,2: [and the *axis* is inclined in an angle of 58° 41′ to the plane of the ecliptic.]

[His mean diameter is 76068 miles: consequently he is nearly 10 times as large as our Earth.] The axis of his poles is to his equatorial diameter as 11 to 12.

His *mass*, compared with that of the Sun considered as unity, is $\frac{1}{3534.08}$: [but his *density* is ·08.]

[The proportion of *light* and *heat* received from the Sun is ·0011; that received by the Earth being considered as unity.]

Saturn is sometimes marked by zones or *belts;* which are probably obscurations in his *atmosphere.* And he is accompanied by seven *satellites.*

The most singular phænomenon, however, attending this planet, is the double *ring* with which he is surrounded.

This ring, which is very thin and broad, is *inclined* to the plane of the ecliptic in an angle of 31° 19′ 12″,0; and *revolves* from west to east, in a period of 10^h 29′ 16″,8, about an axis perpendicular to its plane and passing through the centre of the planet.

The *breadth* of the ring is nearly equal to its distance from the surface of Saturn: that is, about $\frac{1}{3}$ of the diameter of the planet.

The surface of the ring is separated in the middle by a black concentric band, which divides it into *two* distinct rings.

The edges of this ring, being very thin, sometimes *disappear:* and, as this edge will present itself to the Sun twice in each revolution of the planet, it is obvious that the disappearance

appearance of the ring will occur about once in 15 years; but under circumstances oftentimes very different.

[The *intersection* of the ring and the ecliptic is in $5^s\ 20°$ and $11^s\ 20°$: consequently, when Saturn is in either of those signs, his ring will be invisible to us. On the contrary, when he is in $2^s\ 20°$ or $8^s\ 20°$, we may see it to most advantage. This was the case towards the end of the year 1811. Regard, however, must be had to the position of the Earth.]

As viewed from the Earth, the motion of Saturn sometimes appears *retrograde.* The mean arc which he describes in this case is about 6° 18′: and its duration is nearly 139 days. This retrogradation commences, or finishes, when the planet is distant about 108° 54′ from the Sun.

His mean *apparent diameter* is 17″,6.

Telescopic Planets.

URANUS was discovered by Dr. Herschel, March 13, 1781, who gave it the name of the *Georgium Sidus.* It performs its *sidereal revolution* in $30688^d\ 17^h\ 6'\ 16'',2$; or in about 84 Julian years: and it is probably situated at the confines of the planetary system.

Its *distance* from the Sun is upwards of 1800 millions of miles: and its *apparent diameter* is scarcely 3″,9.

Its *mass* compared with that of the Sun considered as unity, is $\frac{1}{19504}$.

Six *satellites* accompany this planet; which move in orbits nearly *perpendicular* to the plane of the ecliptic.

The elements of the four remaining telescopic planets are not yet ascertained with sufficient precision.

Satellites.

The number of satellites in our system, at present known, is eighteen: namely, the *Moon* which revolves round the Earth; four that belong to Jupiter, seven to Saturn, and six to Uranus. The Moon is the only one visible to the naked eye.

They all move round their primary planets, as their centre, by the same law sas those primary ones move round the Sun: namely,

I. *The orbit of each satellite is an ellipse, of which the primary planet occupies one of the foci.*

II. *The areas, described about the primary planet, by the radius vector of the satellite, are proportional to the times employed in describing them.*

 III. *The*

III. *The squares of the times of the revolutions of the satellites, round their respective primary planets, are to each other as the cubes of their mean distances from the primary.*

Moon.

The motions of the Moon are exceedingly eccentric and irregular. She performs her mean *sidereal revolution* in $27^d\ 7^h\ 43'\ 11'',5$. But this period is variable: and a comparison of the modern observations with the ancient proves incontestably an *acceleration* in her mean motion. Her mean *tropical* revolution is $27^d\ 7^h\ 43'\ 4'',7$: and her mean *synodical* revolution is $29^d\ 12^h\ 44'\ 2'',8$

Her *mean distance* from the Earth is 29·982175 times the diameter of the terrestrial equator; or above 237 thousand miles.

The *eccentricity* of her orbit is ·0548553; the mean distance from the Earth being taken equal to unity. But this eccentricity is variable in each revolution.

Her *mean longitude*, at the commencement of the present century, was in $3^s\ 21°\ 36'\ 42'',1$.

Her *velocity* varies in different parts of her orbit. She is swiftest in her perigee (or point nearest the Earth); and slowest when in her apogee (or point furthest from the Earth). Her mean diurnal velocity is equal to $13°\ 10'\ 34'',9$, or about 13 times greater than that of the Sun.

The greatest *equation of her centre* is $6°\ 17'\ 54'',5$.

The mean longitude of her *perihelion* was, at the commencement of the present century, in $8^s\ 26°\ 6'\ 5'',1$: but the line of the apsides has a motion, according to the order of the signs. The period of a sidereal revolution of the apsides is $3232^d\ 13^h\ 56'\ 16'',8$, or nearly 9 years. The period of a tropical revolution of the apsides is but $3231^d\ 11^h\ 24'\ 8'',6$. But these periods are not uniform: for they have a secular irregularity, and are retarded whilst the motion of the Moon itself is accelerated. The period of an *anomalistic* revolution of the Moon is $27^d\ 13^h\ 18'\ 37'',4$.

Her orbit is *inclined* to the plane of the ecliptic in an angle of $5°\ 9'$: but this inclination is variable. The greatest inequality, which sometimes extends to $8'\ 47'',1$, is proportional to the co-sine of the angle on which the inequality in the motion of the nodes depends.

Her orbit, at the commencement of the present century, crossed the ecliptic in $0^s\ 15°\ 55'\ 26'',3$: but the place of her *nodes* is variable. They have a retrograde motion, and make

make a sidereal revolution in $6793^d\ 10^h\ 6'\ 30'',0$; or in about 18·6 Julian years. This variation, however, is subject to many inequalities: of which, the greatest is proportional to the sine of double the distance of the Moon from the Sun; and extends to $1^\circ\ 37'\ 45'',0$ at its maximum. A synodical revolution of the nodes is performed in $346^d\ 14^h\ 52'\ 43'',6$. The motion of the nodes is subject also to a secular inequality, dependent on the acceleration of the Moon's mean motion.

The *rotation* of the Moon on her axis is equal and uniform: and it is performed in the same time as the tropical revolution in her orbit; whence she always presents nearly the same face to the Earth. But, as the motion of the Moon, in her orbit, is periodically variable, we sometimes see more of her eastern edge, and sometimes more of her western edge. This appearance is called the *libration* of the Moon in *longitude*.

The *axis* of the Moon is inclined to the plane of the ecliptic in an angle of $88^\circ\ 29'\ 49''$. In consequence of this position of the Moon, her poles alternately become visible to, and obscured from us: and this phænomenon is called her *libration* in *latitude*.

There is also another optical deception arising from the Moon being seen from the surface of the Earth, instead of the centre. This appearance is called her *diurnal libration*.

There are other inequalities in the Moon's motion, arising from the action and influence of the *Sun*. The principal of these are,

1. The *Evection;* whose constant effect is to diminish the equation of the centre in the syzigies, and to augment it in the quadratures. If this diminution and increase were always the same, the evection would depend only on the angular distance of the Moon from the Sun: but its absolute value varies also with the distance of the Moon from the perigee of its orbit. After a long series of observations, we are enabled to represent this inequality by supposing it equal to the sine of double the distance of the Moon from the Sun, minus the distance of the Moon from its perigee. At its maximum, it amounts to $1^\circ\ 18'\ 2'',4$.

2. The *Variation;* which disappears in the syzigies and quadratures, and is greatest in the octants. It is then equal to $31'\ 44'',1$: whence it is proportional to the sine of double the distance of the Moon from the Sun. Its duration is half a synodical revolution of the Moon.

3. The *Annual Equation*; which follows exactly the same law as the equation of the centre of the Sun, with a contrary

 sign.

sign. For, when the Earth is in its perihelion, the orbit of the Moon is enlarged by the action of the Sun; and the Moon therefore requires more time to perform her revolution. But, as the Earth proceeds towards its aphelion, the Moon's orbit contracts. Hence the period of this inequality is an anomalistic year: and, at its maximum, it amounts to 11′ 15″,9. It is subject to a secular inequality.

The *figure* of the Moon is that of an oblate spheroid, like the Earth. Her mean *diameter* is in the proportion to that of the Earth, as 5823 to 21332; or as 1 to 3·665. Whence her mean diameter will be about 2160 miles.

Her *volume*, compared with that of the Earth, is $\frac{1}{49}$: but her *mass* is only $\frac{1}{68\cdot5}$.

The *apparent diameter* of the Moon varies according to her distance from the Earth. When nearest to us it is 33′ 31″,1; but at her greatest distance it is 29′ 21″,9. Her mean apparent diameter is 31′ 26″,5.

Her mean *horizontal parallax* is equal to 57′ 34″,2.

The *phases* of the Moon are caused by the reflection of the Sun's light; and depend on the relative positions of the Sun, the Earth, and the Moon.

An *eclipse* of the Moon can take place only at the time of her opposition to the Sun; and is caused by her passing through the shadow of the Earth. That shadow is $3\frac{1}{2}$ times longer than the distance between the Moon and the Earth: and its breadth, where it is traversed by the Moon, is about $2\frac{2}{3}$ times greater than the diameter of the Moon. The breadth of the Earth's shadow, where it is traversed by the Moon, is equal to the difference between the semidiameter of the Sun, and the sum of the horizontal parallaxes of the Sun and Moon.

[The Moon cannot be eclipsed, however, if her distance from the place of her node, at the time of her opposition, exceeds 13° 21′: but, if it is within 7° 47′, there will certainly be an eclipse. The duration of the eclipse will depend on the apparent diameter of the Moon, and on the breadth of the shadow at the point where she traverses it.]

The Sun cannot be eclipsed unless the Moon be in conjunction: and then only when the centres of the Sun and Moon are in the same straight line with the eye of the spectator on the Earth. In such case, if the apparent diameter of the Moon be greater than that of the Sun, the eclipse will be *total:* but, if it be less, it will be *annular.* *Partial* eclipses, however, may arise; as in the case of lunar eclipse.

[The Sun cannot be totally obscured for a longer period of

of time than four minutes: but the Moon may be hid from our view for a much longer period.

[The number of eclipses in a year cannot be less than two, nor more than seven.]

Eclipses generally return in the same order and magnitude at the end of 223 lunations. For, in 223 mean synodical revolutions, there are $6585^d\ 7^h\ 42'\ 31'',7$: and, in $6585^d\ 18^h\ 41'\ 45'',6$ there are 19 mean synodical revolutions of the Moon's nodes. Therefore, at the end of $6585^d\ 7^h\ 42'\ 31'',7$, the Moon's mean longitude will be only $28'\ 32''$ behind the mean place of her nodes. In 6585 days there are 18 Julian years and 11 days, if there are *four* leap years in that period: but if there are *five* leap years, they form no more than 18 Julian years and 10 days.

The *atmosphere* of the Moon, if it has any, must be extremely attenuated; and must be more rare than that which we can produce with our best air-pumps.

The *light* of the Moon is 300000 times more weak than that of the Sun. Its rays, collected by the aid of powerful glasses, do not produce any sensible effect on the thermometer.

The *refraction* of the rays of light, at the surface of our Earth, must be at least 1000 times greater than at the surface of the Moon.

Volcanoes and *mountains* are discovered on her surface, by the aid of the telescope.

A body *projected* from the surface of the Moon, with a momentum that would cause it to proceed at the rate of about 8200 feet in the first second of time, and whose direction should be in a line which at that moment passed through the centre of the Earth and Moon, would not fall again to the surface of the Moon; but would become a satellite to the Earth. Its primitive impulse might, indeed, be such as to cause it even to precipitate to the Earth. The stones, which have fallen from the air, may be accounted for in this manner.

Satellites of Jupiter.

By the aid of the telescope we may discover four satellites revolving round Jupiter. The sidereal revolutions of these bodies are given in the following table: together with their mean distances from Jupiter, the semi-diameter of that planet's equator being considered as unity; and likewise their masses, compared with Jupiter considered also as unity.

Satellite.	Sidereal Revolution.		Mean Distance.	Mass.
I.	$1^d\,18^h\,27'\,33'',5$	1^d 769137788148	5·812964	·0000173281
II.	3 13 13 42 ,0	3 551181017849	9·248679	·0000232355
III.	7 3 42 33 ,4	7 154552783970	14·752401	·0000884972
IV.	16 16 31 49 ,7	16 688769707084	25·946860	·000042659 1

First Satellite. The inclination of the orbit of this satellite does not differ much from the plane of Jupiter's orbit. Its eccentricity is insensible.

Second Satellite. The eccentricity of the orbit of this satellite is also insensible. The inclination of its orbit, to that of its primary, is variable; as well as the position of its nodes.

Third Satellite. This satellite has a little eccentricity; and the line of its apsides has a direct but variable motion: the eccentricity itself is also subject to very sensible variations. The inclination of its orbit to that of Jupiter, and the position of its nodes, are far from being uniform.

Fourth Satellite. The eccentricity of this satellite is greater than that of any of the other three; and the line of the apsides has an annual and direct motion of 42′ 58″,7. The inclination of its orbit, with the plane of Jupiter's orbit, forms an angle of about 2° 25′ 48″: but this angle, although stationary about the middle of the last century, has lately begun to increase very sensibly. At the same time the motion of its nodes has begun to diminish.

The motions of the first three satellites are related to each other by a most singular analogy. For, the mean sidereal or synodical motion of the first, added to twice that of the third, is constantly equal to three times the mean motion of the second. And, the mean sidereal or synodical longitude of the first, minus three times that of the second, plus twice that of the third, is always equal to two right angles.

The satellites of Jupiter are liable to be eclipsed by passing through his shadow; and, on the other hand, they are frequently seen to pass over his disk, and eclipse a portion of his surface. This happens, to the first and second satellite, at every revolution: the third very rarely escapes in each revolution: but, the fourth (on account of its great distance and inclination) is seldom obscured.

These eclipses are of great utility in enabling us to determine the longitude of places, by their observation: and they likewise exhibit some curious phænomena with respect to light.

From

From the singular analogy, above alluded to, it follows that (for a great number of years at least) the first three satellites cannot be eclipsed at the same time: for, in the simultaneous eclipses of the second and third, the first will always be in conjunction with Jupiter; and *vice versâ.*

Satellites of Saturn.

Seven satellites may be seen, by means of the telescope, to revolve about Saturn; the elements of which are but little known, on account of their great distance. The following table will show the duration of their sidereal revolutions, and their mean distances in semi-diameters of Saturn.

Satellite.	Sidereal Revolution.		Mean Distance.
I.	$0^d\ 22^h\ 37'\ 30'',1$	0^d 94271	3·080
II.	1 8 53 8 ,7	1 37024	3·952
III.	1 21 18 25 ,9	1 88780	4·893
IV.	2 17 44 51 ,1	2 73948	6·268
V.	4 12 25 11 ,1	4 51749	8·754
VI.	15 22 41 13 ,9	15 94530	20·295
VII.	79 7 54 37 ,4	79 32960	59·154

The orbits of the first six satellites appear to be in the plane of Saturn's ring: whilst the seventh varies from it very sensibly.

Satellites of Uranus.

Six satellites revolve round Uranus: which, together with their primary, can be discovered only by the telescope. The following table will show their sidereal revolutions, and mean distances in semi-diameters of the primary.

Satellite.	Sidereal Revolution.		Mean Distance.
I.	$5^d\ 21^h\ 25'\ 20'',6$	5^d 8926	13·120
II.	8 16 57 47 ,5	8 7068	17·022
III.	10 23 3 59 ,0	10 9611	19·845
IV.	13 10 56 29 ,8	13 4559	22·752
V.	38 1 48 0 ,0	38 0750	45·507
VI.	107 16 39 56 ,2	107 6944	91·008

All these satellites move in a plane which is nearly *perpendicular* to the plane of the planet's orbit, and *contrary to the order of the signs!*

II. *An*

II. *An Account of the Great Derbyshire Denudation. By Mr.* J. Farey *Senior. In a Letter to the Right Hon. Sir* Joseph Banks, *Bart. K.B. P.R.S.**

Sir, I had but recently entered on the survey of Derbyshire and its environs, which under your kind patronage I was induced to commence in the autumn of 1807, and had only cursorily examined the strata, in my way from Charnwood Forest and Breedon in Leicestershire, in order to meet you at Overton Hall, before I perceived clearly, that those principles which contemplate the terrestrial strata as terminating or *ending* in one direction (simple and important as they are), which I had learned under Mr. William Smith in 1801, and which he has so successfully applied in the filling up of his maps of the strata in the south-east and east, and some of the middle parts of England, would fail me, in their application to the strata of Derbyshire, without taking into consideration along with them, not only the denudation, or local stripping off, of patches of strata, some of immense extent and thickness, and even more considerable than those which I had discovered to be missing † from off the Wealds of Kent, Sussex, and Surry, and had explained to you, by a rough section across this great southern denudation in 1806, and such as the valley of Ashover then appeared to present, a more perfect instance of, around us: but that previously to such denudations of the Derbyshire strata, immense dislocations or vertical derangements of very large piles of strata, separated by the fissures, called *faults* by the miners, needed also to be taken into account, for explaining the appearances of the strata and surface of the district, which I was then about to explore: *faults*, exceeding immensely in their extent and quantity of *lift* on one side (or sink on the other) any which had occurred to Mr. Smith, in the tracing of the south-eastern strata of England, where no faults had been discovered, so considerable as to cut off entirely the connection of the strata, or in other words, to bring strata in contact on the surface, whose places in the series were too distant to be known, and readily traced in their order, in the neighbourhood. And in consequence, I judged it necessary, on my return to town, when the winter arrived, to set about the consideration of strati-

* From the Philosophical Transactions for 1811, part ii.

† And such as Dr. William Richardson had found to have been removed in several places, from off the basaltic area in the counties of Derry and Antrim in Ireland, and has named *abruptions*, in his very admirable paper on this district, in the Philosophical Transactions for 1808.

fied

fied masses, broken and dislocated, and then cut or denudated in all the variety of cases and degrees of each, the results of which investigation, will appear in my Report to the Board of Agriculture on Derbyshire, the first volume of which is now in the press *.

With ideas thus extended, I found, on resuming my Survey in the spring of 1808, that some conclusions that I had formed, and had unfortunately committed to paper, in a sketch of a section across the county, were erroneous, and that immense *faults* occurred, in places where their existence had not been proved by miners, or generally understood, which combined with the denudations, that were so apparent in my first journey across the county in the preceding autumn, offered, as I proceeded afterwards in filling up my map, a considerably different explanation of the structure of the country, or section of its strata, from that which I had previously made, and permitted some persons to copy †. The first volume of my Report to the Board of Agriculture abovementioned, has compressed into it, all the most essential particulars of my Survey, which manuscript you did me the honour to examine, and to recommend its adoption to the Board; but as the plan of that Report did not admit of taking an extended or connected view of the great faults or dislocations of the district, I have troubled you with this letter, in order to describe them: previous to which it may be right just to recall to your recollection, a few particulars respecting the British stratification. It is now well known to great numbers of observers, that the thick clay and other strata, on which the metropolis is situated, extend eastward through Essex, Suffolk, and Norfolk to the eastern coast, and in all their extent cover the chalk strata: that these again (the chalk) extend from the Isle of Wight to Flamborough Head, and cover other known strata, which have their regular *basset-edges*, or appearances at the surface, in continuity, to the westward of the limits of the chalk, and of each other; and thus it has been imagined by many, that the whole surface of England could be referred to, or explained by an uninterrupted series of basset-edges of strata, dipping to the S.E. and

* This important volume, to all those interested in the property, the getting or using of the principal British Mineral Products, as well as to the Geologist, may now be had of any bookseller.—EDITOR.

† And which copy, after being altered so as to deviate immensely further from the facts of the case, and in despite of the opinions of the most experienced individuals on the line of section, or that can perhaps be found in any other situation, (see Derbyshire Report, i. p. 163. Note) has since, as I am informed, been published.—EDITOR.

and ranging in continuity from S.W. to N.E. in certain undulating lines, conformable to the surface, from one sea to the other, just as a certain number at the upper part of the series have been shown to do, by Mr. Smith's manuscript maps. But, after passing the edges of the *lias* limestones and clay strata, in our progress to the westward, from any of the south-eastern and eastern parts of England, we find on the surface marks of an immense stratum of red earth or marl, which basseting from under the lias clay and sand, seems once to have extended over all the remainder of the British islands, without being now any where covered by patches of upper strata*, much beyond the continuous edge of the lias strata abovementioned. Instead, however, of seeing the middle and all the western and northern parts of Britain covered by the same red strata, we find now, in this space, numerous local and many very large tracts of strata, surrounded by vertical and connected *faults*, and greatly lifted and tilted; from the surface of which lifted tracts, the upper red earth, and vast and very unequal thicknesses of strata, that lay in regular succession below this red earth, have been denudated, "abrupted," or carried off, leaving thus, a great variety of what have been called coal-fields, or *mineral-basins* †, in which limited tracts, great and most important series of strata, are to be seen basseting (owing to the local denudations), of which the basset-edges, or continued endings, can no where be traced in these islands, as far as I can learn. Large tracts of the intervening spaces, between these denudated mineral basins, are still occupied by the red marl, containing local strata of gypsum, rock-salt, sand, micaceous grit-stone, &c. &c. in its substance, or exposed by denudation; and in others, local strata, or nodules of great extent, or rather, perhaps, rudely crystallized masses of slate, green-stone, sienite, basalt, &c. &c. forming hills or mountains (often intersected by mineral veins) from the tops of which masses, the red marl has in most instances been denudated. It remains a task of great difficulty, yet to be accomplished, to ascertain the lower part of the British series of strata, thus only exposed to view, in local and unconnected tracts, or basins, which are in part often concealed by gravel (frequently so, near their borders), and towards which investigation, little

* Gravels, peat, &c. not being included in this term.

† Of which a fine instance is described by Mr. Edward Martin, in the Philosophical Transactions for 1808¶, and of which the Forest of Dean presents a smaller, but similar instance.

¶ Called the South Wales Mineral Basin; and another around Nailsea in Somersetshire. See p. 323 of our last volume.—Editor.

has

has yet been done. It seems to me, that there are three distinct series of coal-measures, if not more, separated by thick strata of red earths, or marls, not easily distinguished from the upper one above the coal series, or that which underlays the lias strata, as above mentioned, and by thick strata of limestones; each of which red earths, probably, produce anomalous and local strata, or crystallized mountain masses, in different places, where they form the surface; and the fact of such containing no organic remains, may not have arisen from their having been formed before organized beings existed, as those contend who call them *primitive* rocks, but because the circumstances proper to crystallization, were unfitted to the propagation and life of either animals, or vegetables; and may it not be doubted, whether crystallized masses, great or small, are ever the seats of reliquia?

The northern parts of Derbyshire, and the adjoining parts of the surrounding counties, present a denudated tract, and partake of this uncertainty, as to what place in the lower part of the British series of strata, its strata should be referred: from many circumstances, I am inclined to consider the coal-field of Derbyshire, Nottinghamshire, and Yorkshire, underlaying the yellow-lime rock, as lower in the series than any others of the coal-measures alluded to above, and that the fourth limestone rock, which extends from Castleton in Derbyshire, southward to Weaver Hill, near Wooton and Ramsor in Staffordshire, is the very lowest which is known in Britain, and which may account for the circumstance, that the mineral veins and the strata in which they occur in Derbyshire, present some phænomena, which are said to occur no where else.

I shall proceed now to describe the circumstances, under which this great elevation and denudation of part of the Derbyshire strata seems to have happened, which is, by a series of three or four separately lifted tracts, one within the other, as represented in the small sketch map annexed (Pl. I.) The outer or least lifted of these tracts is bounded on the south by a fault, that I have distinguished by a full line, where ascertained, and by slight dots where only inferred, and denominated it the great Derbyshire fault, which is perfectly defined from near Nottingham across Derbyshire, to the north side of Stone in Staffordshire (except in a few places where gravel covers it), by having red marl, lying nearly horizontal, on all its south side, and different strata on its north side, as will be mentioned further on: the

eastern

eastern fault or side of this first raised tract is not visible within the limits of my Survey, like the southern, on account of the vast accumulation of quartz gravel in Sherwood Forest, and the peaty alluvia north of it: but it seems probable to me, that its range is from about the town of Nottingham, east of Mansfield, east of Worksop near Bawtry, west of Thorne in Yorkshire, and how much further north this fault proceeds, before it turns to the west, I am unable to state from my own observations; but from the correspondence of my friend William Smithson, esq. of Heath Hall near Wakefield, a very able observer, I conclude, that the boundary fault on the north of the outer lifted tract, ranging not far from the lower part of the course of the Wharf river, suddenly cuts off, or terminates the great Derbyshire and Yorkshire coal-field to the north, and continues S. of Otley and Keighley* near Colne in Lancashire and Clitheroe, bounding still the coal-field of Lancashire to the north. I am not sufficiently acquainted with the Lancashire strata to hazard a conjecture, as to where this fault turns (or branches perhaps) towards the southward again; but on the west it probably passes not far from Manchester, Stockport in Cheshire, Macclesfield, Congleton, Church-Lawton Salt-works, and joins the great Derbyshire fault, or southern boundary of this very large raised tract, somewhere to the N.W. of Stone in Staffordshire, as I judge, from the information which I have received, of the red marl occupying the surface withoutside this raised tract to the westward, in Cheshire and Staffordshire, as well as south of it in Staffordshire, Derbyshire, and Nottinghamshire, as above mentioned, and on the east of it from Nottingham to Thorne in Yorkshire, and perhaps further northward.

This border, or plain of red marl, has the tract within it so raised, that the yellow, or magnesian lime rock, probably abuts against the marl at the surface of the strata on

* It seems probable, from the accounts which I have received from Mr. Smithson, of the many small coal-basins, or swilleys, as they are called, which occur in the space between Keighley, Hawes, and Richmond, viz. on the N. side of Keighley; on Founton Fell in Craven; Thorpe Fell near Burnsall, Threshfield near Linton, and Anter-Heights near Kettlewell, on the Wharf river; Netherdale Forest near Middlesmoor, on the Nidd river; Slapestones near Hawes, West-Scrafton S.W. Leyburn N.W. and Braithwait-Bank near to Middleham on the Yore river; Hudswell Moor S.W. of Richmond on the Swale river, &c. that all these belong to the lower or calcareous part of the Newcastle coal series, as exhibited in Mr. Westgarth Forster's "Treatise on a Section of Strata," lately published, wherein near 4100 feet thick of strata are described in order.

the east side, under the gravel, &c. from near Nottingham to near Wetherby in Yorkshire. From Lenton E. of Nottingham, to Allestry N. of Derby, the upper parts of the coal-measures in the first raised tract, abut on the red marl: here another great fault, called the zig-zag fault, intersects the boundary fault: from Allestry to the S.E. corner of the Weaver Hills near Wooton in Staffordshire, the second inner tract, with a vastly greater rise than the first, abuts on this southern fault, so as to bring the great limetone-shale (which underlays all the coal-measures) against the red marl on the surface; at this S.E. corner of the Weaver Hills, another great fault (called the great limestone fault) intersects the southern boundary (or great Derbyshire) fault of the raised tract; and from this place to the S.W. corner of the Weaver Hills near Ramsor, a third inner tract, with four hundred yards or more of perpendicular rise, in addition to the last, occasions the fourth, or lowest limestone rock, to abut against, and even make a high hill above the red marl at the foot of it, on the other side of the great Derbyshire fault; which here occasions a sudden derangement of the strata (and a corresponding denudation of the large tract of country to the northward has taken place), far exceeding any thing which has hitherto been mentioned by authors, or conceived probably by any one.

At the S.W. corner of the Weaver Hills above mentioned, the great limestone fault again leaves the south boundary, or great Derbyshire fault, and proceeds northward, after which a corner of the second interior raised tract again presents itself, and the limestone-shale again abuts on the marl, as we pursue the great Derbyshire fault to the westward, owing to the rise being less here by four or five hundred yards, than it was in the third interior tract; but as we proceed southwestward, owing to the dip of the measures on the N. side of the great Derbyshire fault towards the west, the first grit, the first coal-shale, and the second grit rock successively abut against the marl, before the gravel covering commences, east and south of Cheadle, which prevented my tracing this fault any further, within the limits of my Survey.

It seems probable, however, that somewhere S.W. of Cheadle in Staffordshire, a branch sets off from the great Derbyshire fault, or southern boundary of the lifted tracts, and proceeds northward, near to Endon and Bosley in Cheshire; the triangular tract beyond which, to the westward, shown in the map, forming the pottery coal-field, is much

much less raised, perhaps, than any of the other tracts which have been here mentioned*.

If we return to Allestry N. of Derby above mentioned, and trace the zig-zag fault, through Little Eaton, West Hallam, and Ilkeston in Derbyshire, Awsworth, Greasley, Annesley, Kirkby, and Dirty-Hucknal in Nottinghamshire, Alt-Hucknal, Bolsover, Clown, and Barlborough in Derbyshire, Harthill, South-Anston, North-Anston, Dinnington, &c. in Yorkshire, we shall find coal-measures on both sides of it, through its whole length, except in two or three instances, where the yellow lime strata at the top of these coal-measures abut against it for short distances, and between Allestry and Little Eaton, where the limestone-shale below these coal-measures abuts on its W.; but the rise is very considerable and unequal on the N. and W. sides, through its whole length, compared with the other sides, as I have particularly shown in my Report to the Board, and pointed out the great difficulties which this zig-zag fault has presented, to the right understanding the entire of the great Derbyshire and Yorkshire coal-field, by the many very intelligent and able colliers who are found in it.

The first, or outer raised tract, thus bounded by faults (except, perhaps on the N. where my Survey has not extended), shows no very rapid dips or inclinations of the strata, except in very limited spots, and presents on the surface either the yellow lime rock, or the parts of the coal-measures not very far beneath that rock, compared with the whole thickness of these coal-measures.

The great limestone fault (which has been mentioned above) commences in the town of Cromford in Derbyshire, in the first or upper limestone rock, and proceeds through Middleton, Wirksworth, Hopton, Carsington, Ballidon, Parwich, Newton-Grange, and Thorpe in Derbyshire, Ilam, Blore, and Thornwood in Staffordshire, and joins the great Derbyshire fault near Wooton (as above mentioned), with which it coincides along the S. end of the Weaver Hills to near Ramsor, where it again leaves this fault and proceeds near Caldon, Water-Houses, Water-fall, Grindon, Wetton Mill, S. end of Ecton Hill, near Gateham and Narrowdale in Staffordshire, Wolfscote, Beresford, Hartington, Ludwell, Pilsbury, Crowdycote, Dowall, Booth, Thirkelow, Edge-end, Buxton Baths, Black-edge, Dove-hole, crosses

* And which perhaps answers to the South-Wales Coal Basin Report, i. 160.—Editor.

to

to the W. side, and again to the E. side of the *Grand Ridge* * of the island, passes near Sparrow-Pit, Perry-foot, Odin-Mine, Lane-head, Castleton Town, Pindale, Edingtree, Bradwell, Hazlebadge, Quarters-house, and Windmill-houses, and terminates in the first lime rock between Wardlow-Mires and Litton in Derbyshire. If now a line be traced on the same first lime rock, through Wardlow, W. of Little Longsdon, W. of Ashford, through Sheldon, Callenge Low, Middleton by Yolgrave, S. of Gratton, Elton, Winster, Wensley, and Snitterton, W. of Matlock Church, Starkholmes, and Willersley Castle to Cromford Town, shown by very fine dots in the map, this line on the first limestone, may be considered as a kind of hinge, or joint, on which the second inner raised tract, and the third inner raised tract have turned a little, and altered their inclinations with respect to each other and the surrounding tracts (without any vertical derangement at this hinge), so that the great limestone fault above described, from Middleton by Wirksworth, round to the westward through Staffordshire, as above, to Quarters-house near Great Hucklow (with the exception of the short distance between Wooton and Ramsor, and some other trifling ones) has the limestone-shale (or the shale-limestone, &c. belonging to it) on its outside on the surface of the second inner raised tract, for more than fifty miles; but on its other side, owing to the great tilt or rise of the western side of the third inner raised tract, if we begin in Cromford, and pursue the course of the great limestone fault, up Bonsal-Dale, we have at first the first lime on its right or N. side (as well as on its S. side), then the first toadstone, next the second limestone, then the second toadstone, and after its turning to pass through Middleton by Wirksworth, the third limestone also abuts against it, and continues so to do, till the third toadstone appears against it at Hopton, and then the fourth limestone, or lowest known rock of the district, abuts against it all the way round, through Staffordshire to Castleton (with the exception of the hummocks of third limestone at Buxton and at Barmoor in Peak Forest, and a few sunk gulfs of shale) through a length of more than forty-five miles. At the S.E. end of Castleton Town, the third toadstone abuts again on the right or S. side of this great limestone fault, and from thence to the S.W. side of the Windmill-Houses, the third limestone abuts against it, then the second toadstone, the second limestone, the first toadstone, and at

* See that article in Dr. Rees's Cyclopædia lately published.

length the first limestone, before the fault terminates or becomes too inconsiderable to be readily traced, owing to its no longer deranging the order of the strata on the surface, but has the first limestone on both its sides; and thus it happens, that the third inner raised tract, or mineral-field, consisting of the four limestone rocks and three interposed toadstones, and containing about 105,000 acres, has about 51,500 acres of these on its eastern side, occupied by the three upper limestones and the toadstones, and the remaining 53,500 acres in Derbyshire and Staffordshire is occupied by the fourth, or lowest limestone rock, in which only a few mineral veins occur among its numerous open fissures and caverns.

In the sketch map which accompanies this, I have shown a smaller, or fouth inner raised tract, on which Bakewell is situated, in great part surrounded by a fault, which I have thence denominated the great Bakewell fault. I have selected this tract, among other small local raised ones, on account of its approaching in shape and position to the others which surround it, and because it explains several curious appearances of the strata in these parts, which have been, and are still likely to be greatly misrepresented.

The fault to which I allude, may be said to commence in the limestone shale on the E. side of Beeley, to pass on the S. side of the village, across the Derwent and on the S. of Haddon-Hall, continuing across the pastures to the Lathkil river about a quarter of a mile above Alport, then turns S. past the W. end of Alport to the upper mill, thence W.S.W. for about one mile, where this fault again turns to the N. and crosses the Bradford river, and proceeding across the Meadow-place Liberty, crosses Robinstye Mine and the Lathkil river above Over-Haddon mill; bears then a little to the east of the north, and crosses the new Bakewell and Buxton road at the rise of the hill, passes the N. end of Bird's-head Mine, crosses the Wye river about a quarter of a mile above Bakewell Cotton Mill, proceeds near to Rowdale, turns E. towards Nether Burchill, then N.E. following nearly the course of the brook, it continues the same direction until about half a mile E. of Hassop, where it turns to the E. crosses the Derwent again half a mile above Baslow, and terminates in the limestone-shale in Barbrook Dale, as it began. The western side of this fourth inner tract being most raised (similar to the third tract) occasions the great elevation of the shale, and its freestone in the hills E. of Bakewell and N.E. of Haddon-Hall; the sudden appearance of the limestone, on which Haddon-Hall stands, and

and in the quarry S.S.W. of it, on the W. of the road, and thence across the pastures to the Lathkil river; the sudden elevation of the limestone knowls S.W. of Yolgrave, near the shale; and by this same lift, it happens, that the vale of the Bradford suddenly cuts through the first lime rock, as soon as it has crossed this fault, and shows the first toadstone to a considerable height up each side of the valley, but which declines with the dip of the measures in this tract, until the Bradford again gets upon the first toadstone, and then on the first limestone. In like manner, the greater rise of the measures at this fault, on the S.W. of Over-Haddon village occasions the valley of the Lathkil river, which till then had been excavated in the first lime rock, to enter abruptly so deep into the first toadstone, as to lay bare a patch of the second limestone under it in the river, both of which however descend again below the bed of the river, before we get down to the crossing of the Ashburne turnpike road.

This fault also occasions the sudden appearance of shale-limestone on the surface N.W. of it, opposite to first limestone on the other side in Bakewell Fields, and of the first toadstone on the N.W. of Bakewell Cotton-Mill, almost excavated through by the vale of the Wye river, where it abuts against shale or shale-limestone at the northern end of this noted patch of toadstone, the situation and circumstances of which, when compared with those of the other two patches, at the edge of this same raised tract, as above, will be divested of much of that singularity which has been ascribed to it; for we see, that each of the three rivers, which pass on to this fourth inner raised tract, have their excavations cut through the first limestone, so as to expose the first toadstone for some distance, until the more rapid descents of the measures than of the vales, occasion them again to dip and disappear in the bottoms of each of these vales. I am, sir,

Your obliged and very humble servant,

J. Farey, Sen.
Mineral Surveyor.

Upper Crown-Street, Westminster,
January 31, 1811.

III. *Description of a new Levelling-Staff.*

To Mr. Tilloch.

Sir, Having frequently experienced much inconveniency in the use of the levelling-staff on the common construction, on account of the narrow opening in the vane preventing

venting a distinct view of the whole numbers on the staff, and rendering it necessary in many instances to remove the vane for the purpose of reading off, which subjects the operation to much uncertainty, besides which, there is a difficulty in accurately bisecting the central stripe on the vane, the wire in many cases subtending a larger angle than the stripe itself. Many persons, with a view of obviating these difficulties, are in the habit of observing the top or bottom of the vane instead of the centre, and reading off from the top or bottom accordingly: this, however, is more objectionable and uncertain than that of bisecting the central stripe; the wire in most levels subtending an angle of several minutes, and therefore if brought in contact with the top or bottom of the vane, the error will be equal to the semi-diameter of the wire, which I have found in short levels to be equal to an inch in a chain. Others have alternately applied the top and bottom of the vane to the under and upper part of the wire, and taken half the difference between the two readings as the true level point. This, although an accurate, is a tedious method.

The vane represented by the inclosed drawing (Pl. II.) will obviate the necessity of having recourse to such modes of practice in future. I have tried several forms, and find this under all circumstances the best.

The correct bisection of the cross is extremely easy, and three inches of the scale being exposed, no error can arise in reading off.

The vane consists of a circular piece of brass 5 inches diameter, and $\frac{1}{10}$th of an inch thick, having an opening of 3 inches in length, and $\frac{1}{8}$th of an inch less in width than the staff: before the opening is made, the cross is carefully described, and the metal constituting it left entire. That portion of the cross that falls on the plate itself, as well as that which crosses the staff, is to be blacked like the hours of a clock, and the remainder of the plate silvered, by which means it will be visible at a quarter of a mile distance, and the circle itself will easily be bisected at half a mile.

There are two thin brass cheeks riveted to the back of the circle for the purpose of clipping the staff, and for moving the vane agreeably to the direction of the observer.

The clamp usually fixed to the front staff should be flush with the sides, in order that the vane may have its full range without obstruction; which is not the case with many of those now in use.

I am, sir, your most obedient servant,

No. 2, Tower Royal, Nov. 7, 1811. JOSEPH STEEVENS.

IV. *On*

IV. *On the Cause of audible Sound in vibrating Strings, Tuning-Forks, &c.; on the Use of* HAWKINS'S *Mouth Tuning-Forks; on Earl* STANHOPE'S *proposed Steel Piano-Forte Strings, &c. By a* CORRESPONDENT.

To Mr. Tilloch.

SIR, THAT surprising individual, Mr. John Gough of Middleshaw, who though unfortunately deprived of sight, from his infancy I believe, has in a remote corner of the kingdom, acquired a deep knowledge of mathematics and natural philosophy, which he often displays in Mr. Nicholson's respectable Journal, and who in the 1st and 2d octavo volumes of that work, successfully combated the subtilties of a most learned LL.D. and F.R.S. who had shortly before availed himself (rather unfairly) of his facilities of access to the Philosophical Transactions, to run down that excellent and unparalleled work on Sounds, the "Harmonics" of the late Dr. Robert Smith of Cambridge; has in the last number of Mr. Nicholson's Journal, given a paper, wherein he shows by an experiment on a musical string, one end of which was fastened to the top of a table, and the other to a small cylinder of wood held in the hand, and by which the string was tight pulled, at the same time that it was set in vibrating motion, that the pulses excited in the ear by the sound, do not proceed direct from the string, as most if not every writer on acoustics have represented to be the case, but *from the fibres of wood in the table*, agitated by the vibrations of the string, analogously to the strokes of a drumstick on its parchment cover, or the fingers on that of a tamborine, but repeated with extreme quickness and regularity. In further confirmation of this ingenious conclusion of Mr. Gough, I beg to mention to your musical readers, a fact, which without doubt many of them must have often noticed, viz. that a tuning-fork gives out no audible sound, after that excited by the mere stroke given to it, while held in the hand; and that it is essential, to rest the end of its handle on a table or firm piece of wood to hear its tone; and in order that this tone may be clear and perfect, it is best to have the end of the handle of a tuning-fork wrought to a blunt point, that it may have only one, and that a firm bearing on the wood, for if knobbed or flat at the end, as they are too often made for sale, they are apt to chatter or give a jarring and interrupted sound.

Mr. J. J. Hawkins of Great Titchfield-street, is mentioned in the article *Concert Pitch* in Dr. Rees's New Cyclopædia, to have applied this principle, of the tuning-fork exciting other bodies to sound, to avoid the disagreeable sight, sound and effects of a tuning-fork when struck on a table or other

piece of furniture (often to bruise and damage it) and then set upright thereon to sound, by the adoption of a very small and slender steel tuning-fork (that might be carried in a toothpick case) the handle of which being held fast between the fore teeth, the two legs of the fork are pinched towards each other with some force between the thumb and finger (during which the lips may be used to assist in holding it) and suddenly let go, by which it seems, that vibrations are excited in the teeth and bones of the jaws of the operator, which effectually give him the sound, without its being audible to any other person, and who has also his two hands at full liberty for the necessary tuning operations. Mr. Hawkins did, and perhaps now does, manufacture these useful and elegant *mouth tuning-forks* for sale.

The above facts tend strongly to show, that improvements in the strength and quality of tone in our stringed instruments are to be sought for in the sonorous or elastic qualities of the materials of which the frames and supports of the strings, and their cases too perhaps are made, and in their soundness and perfection of framing and workmanship, a thing indeed pretty well understood in the trade of instrument-making, and not in the temper or quality of the metallic strings that are used to excite the wood to sound, as Earl Stanhope has for a long time fondly imagined, and has I am told, gone so far as to the manufacturing of steel wire on purpose, at his country seat, for the making of instruments with single strings that are to out-do those with two or three that are in common use, and to whom perhaps these hints may not be unimportant.

Mr. William Burdy's Patent Scheme, (see the Monthly Magazine for last month, p. 573,) of covering both metal and cat-gut strings with platina wire to increase their *weight* and specific gravity, with the view " to increase the power of vibration," though he says " *it is found*, that the purity and power of tone *is increased with the quantity* (of lapped platina wire) used," I am inclined to consider as very liable to fail of its professed object, on the principle above stated; having, I confess, but slight faith in what patent specifications state, to have been found or proved by experiments, after the many similar declarations that I have read for years past, respecting the " gaining of power," perpetual motions and other equally absurd and impossible things, for which as well as *old* inventions, any persons may freely take out patents, if they can but pay *the fees* of office.

This passive kind of elasticity in the fibres of wood, bone, &c. which thus fits them to receive and transmit to the ear vibrations *of any given velocity*, while stretched strings and columns of air in pipes, &c. can only yield

sounds determined by their lengths (their lateral dimensions, weights and tensions and the state of the air remaining the same) and even to receive the most surd and incommensurate vibrations at the same instant (whether in the same or in different parts of the wood?) and which scarcely ever coincide, as readily as those which are commensurate and often coincide, as is exemplified in the striking of a single note, a discordant or a tempered interval, or a perfect concord, on a stringed instrument, as a piano-forte, harp, &c. seems well worthy the consideration of those more learned among your readers than myself; who am,

Yours, &c. B.

V. *On the Nomenclature of the New London Pharmacopœia.*

To Mr. Tilloch.

Sir, I entirely coincide with the observations of your sensible correspondent, respecting the pedantic affectation of the Nomenclature of the New Pharmacopœia, as well as the danger that must result from the use of appellations so nearly resembling each other, both in writing and sound, applied to substances so very different in their properties. Within my own circumscribed range of observation, I am acquainted with two instances where five grains of *corrosive sublimate* were actually taken instead of the same quantity of *calomel*, in consequence of the omission of, or inattention to, a *sub*. The persons, being adults, recovered; but to a child the consequences would probably have been fatal. It is much to be wished that those to whom the care of the public health is intrusted by charter, would be more careful how they permit the frivolous pretension to neology to interfere with a conscientious discharge of their important duty.

The absurdity of a proposition may sometimes be illustrated by transferring it to a science different from that in which custom has in some measure established it. It will not be denied that the theories of medicine, or the manner of talking concerning the causes of disease, are as frequently changed as those of chemistry. Now, sir, suppose the College of Physicians, by the authority vested in them, were every ten years to change the names of the various diseases to which our frail bodies are liable; that *gout*, for example, should be termed *tenesmus*, because it prevents its victim from moving, or any other equally absurd alteration, every person must be sensible what confusion would be the result.

I do not deny that the adoption of new appellations has tended to the improvement of chemistry, because many per-

sons have been induced to inquire whether these names were imposed with propriety. But why should these changes be perpetually introduced into a science the business of which is with life; to which chemistry is subservient only in a remote degree? Diseases were cured before chemical remedies were invented. And where is this alteration of names to end? If the discoveries of Mr. Davy are established, the names of the alkalies are already absurd. Why might not these three substances be termed *ammonia*, *kali*, and *barilla?* They are very distinct, and convey to our minds no adventitious ideas. And the substances they designate may remain either in the vegetable or mineral kingdom, as future experience may determine, without any occasion to alter their denominations.

In looking into Duncan's late edition of the Pharmacopœia, we find five and even six names applied to one substance; some of which are current in London, others in Dublin, and another kind only is understood in Edinburgh. Suppose an individual were to pass by a different name in each of these capitals, the law would find it some difficulty in recognising him.

The *subs* and *supers* bear some resemblance to the *aps* and the *macs* and the *o's*, by which certain nations attempt to indicate family affinities, but every one knows the confounding of individual personality thence resulting; and that if you are in search of a Mr. O'Flannagan, you must not only designate him by his patronymic, but also his christian name, to which it is very requisite to add that of the county, the village, and the hamlet where he was born, and perhaps his numerical order in the series of births of his prolific progenitors. ONOMOS.

VI. *General Method for determining the Orbits of Comets. By* M. LAPLACE *.

THE present method will be divided into two parts: in the first part we shall give the means of obtaining nearly the perihelion distance, and the instant of the passage of the comet by this point: in the second part we shall determine precisely all the elements of the orbit, supposing the latter to be nearly known.

Accurate Determination of the Perihelion Distance, and of the Instant of the Passage of the Comet by this Point.

1. We shall take three, four, five or more observations

* Translated from M. Laplace's *Théorie du Mouvement et de la Figure des Planètes*, a work now become very scarce.—EDIT.

of

of the comet equally as far as possible removed from each other: we should embrace within four observations an interval of 30 degrees, and within five observations an interval of 36 or 40 degrees, and so forth: but the interval comprehended between the observations must always be the larger the greater the number, in order to diminish the influence of their errors.

This being done, let $\beta, \beta', \beta'', \beta'''$, &c. be the successive geocentric longitudes of the comet; $\gamma, \gamma', \gamma'', \gamma'''$, &c. the corresponding northern latitudes, the southern latitudes being supposed to be negative. Divide the difference $\beta'-\beta$ by the number of days which separate the second from the first observation: divide in the same way the difference $\beta''-\beta'$ by the number of days which separate the third from the second observation: divide also the difference $\beta'''-\beta''$ by the number of days which separate the fourth from the third observation, and so forth. Let $\delta\beta, \delta\beta', \delta\beta''$, $\delta\beta'''$, &c. be the consequence of these quotients.

Divide the difference $\delta\beta'-\delta\beta$ by the number of days which separate the third from the first observation: divide in the same way the difference $\delta\beta''-\delta\beta'$ by the number of days which separate the fourth from the second observation: divide also the difference $\delta\beta'''-\delta\beta''$ by the number of days which separate the fifth from the third observation, &c. Let $\delta^2\beta, \delta^2\beta', \delta^2\beta''$ be the consequence of these quotients.

Divide the difference $\delta^2\beta'-\delta^2\beta$ by the number of days which separate the fourth from the first observation: divide in the same way the difference $\delta^2\beta''-\delta^2\beta'$ by the number of days which separate the fifth from the second observation, &c. Let $\delta^3\beta, \delta^3\beta'$, &c. be the consequence of these quotients. We may go on in this way until we succeed in forming $\delta^{n-1}.\beta$, n being the number of the observations employed. This being accomplished,

2. Take a mean or nearly mean epoch between the instants of the two extreme observations, and by naming i, i', i'', i''', &c. the number of days by which it precedes every observation; i, i', &c. being supposed to be negative for all the observations anterior to this epoch; the longitude of the comet after a small number z of days counted from the epoch, will be expressed by the formula

$$
\begin{aligned}
&\beta - i.\delta\beta + i.i'.\delta^2.\beta - i.i'.i''\,\delta^3.\beta + i.i'.i''.i'''.\delta^4.\beta - \&c.\\
&+ z.\left\{\begin{array}{l}\delta.\beta - (i+i').\delta^2.\beta + (i.i' + i.i'' + i'.i'').\delta^3.\beta \\ \quad -(i\,i'\,i'' + i\,i'\,i''' + i.i''.i''' + i'.i''.i''').\delta^4.\beta \\ \quad + \&c.\end{array}\right\} \ldots (p)\\
&+ z^2.\left\{\begin{array}{l}\delta^2\beta - (i+i'+i'').\delta^3.\beta + (i.i' + i.i'' + i.i''' \\ \qquad + i'.i'' + i'.i''' + i''.i''').\delta^4\beta - \&c.\end{array}\right\}
\end{aligned}
$$

The coefficients of $-\delta.\beta$, $+\delta^2\beta$, &c. in the part independent

dent of z, are: 1st, the number i; 2d, the product of the two numbers, i and i'; 3d, the products of the three numbers i, i', i'', &c.

The coefficients of $-\delta^2.\beta$, $+\delta^3.\beta$, $-\delta^4.\beta$, &c. in the part multiplied by z, are: 1st, the sum of the two numbers i and i'; 2d, the sum of the products two by two, of the three numbers i, i', i''; 3d, the sum of the products three by three of the four numbers i, i', i'', i''', &c.

The coefficients of $-\delta^3.\beta$, $+\delta^4.\beta$, $-\delta^5.\beta$, &c. in the part multiplied by z^2, are: 1st, the sum of the three numbers i, i', i''; 2d, the sum of the products two by two of the four numbers i, i', i'', i'''; 3d, the sum of the products three by three of the five numbers i, i', i'', i''', i'''', &c.

By working in the same way on the latitudes of the comet, its latitude, according to the number z of days since the epoch, will be expressed by the following formula,

$$\begin{aligned}
&\gamma - i.\delta\gamma + i.i'.\delta^2.\gamma - i.i'.i''.\delta^3.\gamma + i.i'.i''.i'''.\delta^4\gamma - \&c.\\
&+ z.\left\{\begin{array}{l}\delta\gamma - (i+i').\delta^2\gamma + (i.i' + i.i'' + i'.i'').\delta^3\gamma\\ \quad -(i.i'.i'' + i.i'i''' + i.i''.i''' + i'.i''.i''').\delta^4\gamma\\ \quad + \&c.\end{array}\right\} \ldots (q)\\
&+ z^2.\left\{\begin{array}{l}\delta^2.\gamma - (i+i'+i'').\delta^3.\gamma + (i.i' + i.i' + i.i'''\\ \qquad\qquad + i'.i'' + i'.i''' + i''.i''').\delta^4\gamma - \&c.\end{array}\right\}
\end{aligned}$$

This being done, we shall have α equal to the part independent of z in the formula (p).

By reducing into seconds the coefficieut of z, and subtracting from the logarithm of this number of seconds, the logarithm 3·5500072, we shall have the logarithm of a number which we shall designate by a.

By reducing into seconds the coefficient of z^2, by afterwards taking the logarithm of the double of this number of seconds, and subtracting from this logarithm the following, 1·7855894, we shall have the logarithm of a number which we shall designate by b.

We shall afterwards have θ equal to the part independent of z in the formula (q).

By reducing into seconds the coefficient of z, in this formula, and by subtracting from it 3·5500072, we shall have the logarithm of a number which we shall designate by h.

By reducing into seconds the coefficient of z^2 in this same formula, and by subtracting 1·7855894 from the logarithm of the double of this number of seconds, we shall have the logarithm of a number which we shall designate by l.

It is upon the precision of the values of a, b, h, and l, that the exactness of the following method depends; and as their formation is very simple, we must choose and multiply the observations so as to obtain them with all possible rigour. These quantities are the differentials $\left(\frac{d\alpha}{dt}\right)$; $\left(\frac{d^2\alpha}{dt^2}\right)$;

$\left(\frac{d\theta}{dt}\right)$ and $\left(\frac{d^2\theta}{dt^2}\right)$, which we have expressed, for the sake of greater simplicity, by the foregoing letters.

If the number of observations is an odd one, we should fix the epoch at the instant of the mean observation, which will dispense with our calculating the parts independent of z, in the two preceding formulæ; for it is visible that these parts are respectively equal to the longitude and to the latitude of the mean observation.

In order to elucidate what has been said, by an example, we shall select the second comet discovered by M. Mechain in 1781, and the orbit of which he calculated according to this method: the observations which this learned astronomer chose for this purpose, are referred to the same hour of the day, viz. 8h 29′ 44″ mean time at Paris: the following are the observations:

	Geocentric Longitude of the Comet.	*Northern Latitude.*
1781. Nov. 14	$307^\circ\,14'\,45'' = \beta$	$55^\circ\,17'\,9'' = \gamma$
17	$306^\circ\,57'\,32'' = \beta'$	$44^\circ\,17'\,12'' = \gamma'$
19	$306^\circ\,51'\,26'' = \beta''$	$39^\circ\,14'\,48'' = \gamma''$
22	$306^\circ\,44'\,53'' = \beta'''$	$33^\circ\,49'\,1'' = \gamma'''$
25	$306^\circ\,41'\,37'' = \beta''''$	$29^\circ\,58'\,43'' = \gamma''''$

By taking for the epoch, the instant of the mean observation, *i. e.* the 19th of November, at 8h 29′ 44″, we have

$$i = -5,\ i' = -2,\ i'' = 0,\ i''' = 3,\ i'''' = 6,$$

which gives

$\delta\beta = -5'\,44'',33$	$\delta\gamma = -3^\circ\,39'\,59'',0$
$\delta\beta' = -3'\,3'',0$	$\delta\gamma' = -2^\circ\,31'\,12'',0$
$\delta\beta'' = -2'\,11'',0$	$\delta\gamma'' = -1^\circ\,48'\,35'',667$
$\delta\beta''' = -1'\,5'',53$	$\delta\gamma''' = -1^\circ\,16'\,46'',0$
$\delta^2\beta = 32'',266$	$\delta^2\gamma = 13'\,45'',4$
$\delta^2\beta' = 10'',4$	$\delta^2\gamma' = 8'\,31'',267$
$\delta^2\beta'' = 10'',945$	$\delta^2\gamma'' = 5'\,18'',278$
$\delta^3\beta = -2'',733$	$\delta^3\gamma = -39'',2666$
$\delta^3\beta' = 0'',0681$	$\delta^3\gamma' = -24'',1236$
$\delta^4\beta = 0'',2546$	$\delta^4 = 1'',3766$

The formula (p) will therefore give for the geocentric longitude of the comet, according to the small number z of days reckoned from the epoch,

$$306^\circ\,51'\,26'' - 153'',46\,.z + 10'',54\,.z^2,$$

and the formula (q) will give for the expression of its latitude,

$$39^\circ\,14'\,48'' - 7855'',16\,.z + 535'',4\,.z^2,$$

from which we extract

$$\alpha = 306^\circ\,51'\,26'',$$

$$a = -0,0432501,\ b = 0,345366,$$

$$\theta = 39^\circ\,14'\,48'',$$

$$h = -2,213844,\ l = 17,54354.$$

2d. We

2d. We shall determine by the astronomical tables the longitude of the earth seen from the sun at the instant which we have chosen for our epoch : let A be the longitude, R the corresponding distance from the earth to the sun, and R' the distance which answers to the longitude $90° + A$, of the earth : we shall form the four equations

$$r^2 = \frac{x^2}{\cos^2\theta} + 2\,Rx.\cos(A-\alpha) + R^2 \ldots (1)$$

$$y = \frac{R.\sin(A-\alpha)}{2a}.\left\{\frac{1}{R^3} - \frac{1}{r^3}\right\} - \frac{bx}{2a} \ldots (2)$$

$$\left.\begin{aligned} y = -x.\left\{h.\operatorname{tang}\theta + \frac{l}{2h} + \frac{a^2.\sin\theta.\cos\theta}{2h}\right\} \\ + \frac{R.\sin\theta\,\cos\theta}{2h}.\cos(A-\alpha).\left\{\frac{1}{r^3} - \frac{1}{R^3}\right\} \end{aligned}\right\} \ldots (3)$$

$$\left.\begin{aligned} o = y^2 + a^2.x^2 + \left\{y.\operatorname{tang}\theta + \frac{bx}{\cos^2.\theta}\right\}^2 \\ + 2y.\left\{(R'-1).\cos(A-\alpha) - \frac{\sin(A-\alpha)}{R}\right\} \\ + 2ax.\left\{(R'-1).\sin(A-\alpha) + \frac{\cos(A-\alpha)}{R}\right\} \\ + \frac{1}{R^2} - \frac{2}{r}. \end{aligned}\right\} \ldots (4)$$

In order to draw from these equations the values of the three unknown quantities x, y, and r, we shall begin by considering if, abstraction being made of the sign, b is greater or less than l; in the former case we shall make use of the equations (1), (2) and (4); we shall form a first hypothesis for x, by supposing it, for instance, equal to unity; and we shall extract from it by means of the equations (1) and (2), the values of r and y; we shall afterwards substitute these values in the equation (4), and if the remains are null, it will be a proof that the value of x has been well chosen; but if the remains are negative, we shall increase the value of x, and diminish it if the remains are positive. We shall also have by means of a small number of trials, the true values of x, y, and r; but as these unknown quantities may be susceptible of several values, we must choose that which satisfies precisely or nearly to the equation (3).

In the second case, *i. e.* if we have $l > b$, we shall make use of the equations (1), (3) and (4), and then it will be the equation (2) which will serve as the verification.

Having

Having thus the values of x, y, and r, we shall form the quantity

$$P = \frac{x}{\cos^2\theta} \cdot \left\{ y + hx.\text{tang}\,\theta \right\} + Ry.\cos\,(A-\alpha)$$
$$+ \, x \left\{ (R'-1).\cos\,(A-\alpha) - \frac{\sin(A-\alpha)}{R} \right\}$$
$$+ \, Rax.\sin\,(A-\alpha) + R.(R'-1).$$

The perihelion distance D of the comet will be

$$D = r - \tfrac{1}{2}.P^2;$$

the cosine of the anomaly v of the comet will be given by the equation

$$\cos^2 \tfrac{1}{2} v = \frac{D}{r};$$

from which we shall conclude, by the table of the movement of the comets, the time consumed in traversing the angle v*. In order to have the instant of the passage by the perihelion, we must add this time to the epoch, if P is negative, and subtract it if P is positive, because in the former case the comet approaches the perihelion, and in the second case it removes from it.

With respect to the second comet of 1781, the epoch being fixed as above, on the 19th November, at $8^h\ 29'\ 44''$, we have at this epoch

$$A = 57^\circ\ 57'\ 4'',$$
$$R = 0{,}987248, \quad R' = 0{,}988820,$$

the equations (1), (2), (3) and (4) become thus

$$r^2 = 1{,}667387.x^2 - 0{,}7106137.x + 0{,}974653 \ldots (1)$$
$$y = -\,11{,}0665 + \frac{10{,}6484}{r^3} + 3{,}9927.x \ldots (2)$$
$$y = 5{,}771014.x + \frac{0{,}03931687}{r^3} - 0{,}04086053 \ldots (3)$$
$$0 = y^2 + 0{,}00187057.x^2.$$
$$+ [0{,}8169372.y - 3{,}691334.x]^2 - 1{,}8320446.y \ldots (4).$$
$$+ \, 0{,}0324357.x + 1{,}026006 - \frac{2}{r}.$$

* Call, as above, D the perihelion distance of the comet, U its anomaly, *i. e.* the angle formed by its vector radius with the axis of the parabola which it describes, lastly t, the time passed since the perihelion passage. This being done, according to the laws of parabolic motion, the time t and the anomaly U are united together by the following ties:

$$(1) \ldots . t = \frac{D^{\frac{3}{2}} T}{\pi \sqrt{2}} \left\{ \text{tang}\,\tfrac{1}{2} U + \tfrac{1}{3}\,\text{tang}^3\,\tfrac{1}{2} U \right\},$$

in which π is the demi-circumference, or 3,14159265, and T the duration of the sidereal revolution of the earth, or 365 days 256383. U being given, it is easy to calculate t by this formula. But if t is given, the search for the tang $\frac{?}{?}$ U requires the resolution of these equations of the 3d degree. In order to avoid this difficulty, astronomers have formed a table of values of t in a parabola in which D will be equal to unity, and from this table when once calculated, we may extract the values of U; t being known. This is what we call a table of the motion of comets. We may supply the place of this table by resolving the equation (1) by some trials,

As

As we have in this particular case $l > b$, we must employ the equations (1), (3), and (4). These three equations give

$$x = 0{,}39107,$$
$$y = 2{,}258355,$$
$$r = 0{,}9755798.$$

These values satisfy the equation (2) as much as we can expect of an equation which cannot be very exact on account of the little movement of the comet in longitude. By substituting them in the expression of P, we find

$$P = -\ 0{,}185628.$$

The negative sign of P makes known that the comet has not yet attained its perihelion. We aftewards find the perihelion distance $D = 0{,}9583509$, and the anomaly v of the comet, equal to $15^{\circ}\ 16'\ 24''$, which answers to 10 days 40334: from which it follows that the perihelion passage took place on the 29th of November at $18^{h}\ 10'\ 34''$, mean time at Paris. Having thus obtained nearly the perihelion distance and the instant of the passage of the comet by this point, we may correct them by the following method, which has the advantage of being independent of an intimate knowledge of the other elements of the orbit.

Exact Determination of the Elements of the Orbit, when we know pretty nearly the Perihelion Distance and the Instant of the Passage of the Comet by this Point.

3. We shall select three observations removed from the comet: by afterwards setting out from the perihelion distance, and from the instant of the passage by this point, determined by what precedes, we shall easily calculate the three anomalies of the comet, and the three vector radii corresponding to the instants of the three observations; let v, v' and v'' be these anomalies, those which precede the passage of the comet by the perihelion being necessarily supposed to be negative: further let r, r', r'' be the corresponding vector radii of the comet, $v'-v$ and $v''-v$ will be the angles comprehended between r and r' and between r and r''; let U be the first of these angles and U' the second.

Let us also call a, a', a'', the three geocentric longitudes observed of the comet; θ, θ', θ'', its three geocentric latitudes, the southern latitudes being supposed to be negative: C, C', C'', the three corresponding longitudes of the sun; R, R', R'', its three distances from the earth; β, β', β'', the three heliocentric longitudes of the comet; ϖ, ϖ', ϖ'', its three heliocentric latitudes. This being done,

We will imagine the letter S at the centre of the sun, the letter T at the centre of the earth, the letter C at the centre of

of the comet, and the letter C' at its projection in the plane of the ecliptic; we shall have the angle STC', on taking the difference of the geocentric longitudes of the sun and the comet; by afterwards adding the logarithm of the cosine of this angle with that of the cosine of the geocentric latitude θ of the comet, we shall have the logarithm of the cosine of the angle STC; we shall therefore know in the triangle STC, the side ST or R, the side SC or r, and the angle STC; we shall thus have by rectilinear trigonometry the angle CST; we shall afterwards have the heliocentric latitude ϖ of the comet by means of the equation

$$\sin \varpi = \frac{\sin \theta \sin CST}{\sin CTS}.$$

The angle TSC' is the side of a spherical rectangular triangle, the hypothenuse of which is the angle TSC, and one of the sides of which is the angle ϖ; from thence we shall easily extract the angle TSC', and consequently the heliocentric longitude β of the comet.

We shall have in the same manner ϖ', β', ϖ'' and β'', and the values of β, β', β'' will show whether the motion of the comet be direct or retrograde.

If we conceive the two arcs of latitude ϖ and ϖ' united at the pole of the ecliptic, they will there form an angle equal to $\beta'-\beta$; and in the spherical triangle formed by this angle, and by the sides $90^\circ-\varpi$ and $90^\circ-\varpi'$, the side opposite to the angle $\beta'-\beta$ will be the angle at the sun comprehended between the two vector radii r and r'. We shall easily determine it by the known analogies of spherical trigonometry, or by the following formula:

$$\cos V = \cos(\beta'-\beta).\cos \varpi.\cos \varpi' + \sin \varpi.\sin \varpi',$$

in which V represents this angle.

By calling V' in a similar manner the angle formed by the two vector radii r and r'', we shall have

$$\cos V' = \cos(\beta''-\beta).\cos \varpi.\cos \varpi'' - \sin \varpi.\sin \varpi''.$$

Now if the perihelion distance and the instant of the passage of the comet by this point were exactly determined, we shall have

$$V = U \text{ and } V' = U';$$

but as that will almost never happen, we shall suppose

$$m = U - V;\ n = U' - V'.$$

We shall here observe that the calculation of the triangle STC, gives for the angle CST, two different values, viz. CST and 180°; 2dly, $STC-CST$. We shall thus have two different values for each of the quantities β, ϖ, β', ϖ', β'', ϖ''. Most frequently the nature of the motion of

of the comet will make known the value of CST, of which we ought to make use, particularly if these two angles are very different; for then one of them will place the comet further than the other from the earth, and it will be easy to ascertain by the apparent motion of the comet, at the instant of the observation, which of the two ought to be preferred. In a great number of cases, one of them will be negative, and must consequently be rejected; but if any uncertainty remains on this head, we might always determine the true values of β, β', β'', by observing to take for β and β', the two angles which render V very little different from U, and to take for β and β'' the two angles which render V' very little different from U'.

We shall afterwards form a second hypothesis, in which, by preserving the same instant of perihelion passage with the above, we shall vary the perihelion distance by a small quantity, for example, by the fiftieth part of its value, and we shall find out in this hypothesis the values of $U-V$, and of $U'-V'$; thus,

$$m' = U - V,\ n' - U' - V';$$

finally, we shall form a third hypothesis, in which, by preserving the same perihelion distance as in the first, we shall vary by half a day, or a whole day (more or less) the instant of the perihelion passage. We shall find out in this new hypothesis, the values of $U-V$ and of $U'-V'$; thus,

$$m'' = U - V,\ n'' = U' - V';$$

this being done, if we call u the number by which we ought to multiply the supposed variation in the perihelion distance in order to have the true one, and t the number by which we ought to multiply the supposed variation in the instant of the perihelion passage in order to have the true instant, we shall have the two equations,

$$u\,(m-m') + t\,(m-m'') = m,$$
$$u\,(n-n') + t\,(n-n'') = n,$$

from which we shall extract u and t; and consequently the perihelion distance corrected and the true instant of the passage of the comet by this point.

The foregoing correction supposes that these elements determined by the first approximation, are sufficiently exact to treat as infinitely small their differences from the true: but if the second approximation did not still appear sufficient, we might have recourse to a third by operating on the elements already corrected, as has been done upon the first: we must only take care to make them undergo smaller variations. But in most cases this third approximation

mation will be useless, particularly if, in the first, we use four or five well selected observations.

We may also, in the correction of the first elements, make use of the second differences in the following manner.

Instead of calculating the values of U, U', V and V' in the three hypotheses, we shall calculate them in five hypotheses, viz. 1. With the elements found by the first approximation. 2. By varying the perihelion distance by a very small quantity. 3. By varying it by double this small quantity. 4. By preserving the same perihelion distance as in the first hypothesis, and varying by a small interval the instant of the perihelion passage. 5. By varying the same instant double this interval. Let m, m', m'', m''', m'''' be the values of $U-V$; n, n', n'', n''', n'''' the values of $U'-V'$: then in order to determine the values of u and t, we shall form the two equations,

$$(4m'-3m-m'').u+(m''-2m'+m).u^2+(4m'''-3m-m'''').t$$
$$+(m''''-2m'''+m).t^2+2m=0,$$
$$(4n'-3n-n'').u+(n''-2n'+n).u^2+(4n'''-3n-n'''').t$$
$$+(n''''-2n'''+n).t^2+2n=0.$$

The values of u and of t which satisfy these equations will be more precise than the foregoing. Although in most cases this overmuch precision is useless, it is nevertheless indispensable in forming these equations, at all times when the terms depending on the second differences may be of the same order with those which depend on the first differences; which will happen, for instance, when in one of the observations the vector radius of the comet will be almost perpendicular to the visual ray from the earth to the comet.

[To be continued.]

VII. *A Case of Morbus Pedicularis. Communicated by* John Andree, *Esq. Surgeon.*

A. R. esq. 35 years of age, of a very healthy and strong constitution, had for some years past, particularly when heated by good living and in warm rooms, been often troubled with a prickly itching on the surface of the body, armpits and thighs. In the summer of last year, on coming out of a warm bath at Brighton, he discovered an insect on his thigh.

This circumstance induced him to suspect that the itching he had so long been troubled with, might have been caused by insects. From that time until he applied to me

 on

on December 7, 1811, he had daily combed out from the armpits, body and thighs, from twelve to between twenty and thirty living insects; and some he picked out of the skin, as they had firmly attached themselves thereto; seeming to have partly burrowed into the skin. He was induced to use a small-toothed comb, from being remarkably hairy on the body, thighs, and armpits. I prescribed flores sulphuris internally, for him to take as much as his bowels would bear without operating more than once or twice daily; and to use externally a lotion composed of a strong solution of hydrargyrus muriatus. On the 10th, when I visited him, I had the satisfaction to find the remedies had produced a good effect, the itching having abated, and the number of insects daily combed out diminished to about half the former number.

By persevering in the use of these remedies to the end of the month, he was free from the disorder.

On a minute examination of the insect, it appeared to be nearest in resemblance to the *pediculus inguinalis;* being a smaller and more delicately formed insect than that which infects the head.

It is to be remarked, that this gentleman, who is very cleanly in his person, putting on clean linen every day, does not remember ever having lice in his head, nor on the groins.

In the course of a practice of 30 years, I have not met with a similar case: and on looking into several authors find it mentioned in such terms as to induce me to believe it to be very uncommon, as few cases of the disease are related.

"*Ulyssis Aldrovandi de animalibus insectis liber quintus.* Aristotel. duo tantum pediculorum genera nata fuere; primum grandius hominibus valde familiare a capite orti, et toto corpore errans. Alterum ferum vocavit, durius eo, quod magna ex parte provenit, et corpori detrahi difficilius: hoc communi omnium probatissimorum medicorum judicio, illud est quod plactulas nonnulli et plattas, Itali piattolas et piattones a latitudine corporis dicunt. Galli morpiones, Arabes gardan," &c.

The same author mentions one instance of the disorder ending fatally: "Pherecydem Syrum pediculari morbo interiisse;" and adds, "Qui morbum patitur primum veluti scabiei cujusdam pruritu allectus, corpus scalpit, voluptate simul et dolore perceptis *: deinde exorientibus pe-

* These symptoms were exactly similar to those of this case.

diculis

diculis simul effluente sanie, morbi acerbitate, ac dolore percitus, unguibus corpus lacerat," &c.

The same author, among many instances of this disease being fatal, mentions that the English king Edmond died of the pedicular disease.

Sauvage, (Nosologia methodica. Ordo septimus, Classis X. Phthiriasis pedicularis. La maladie péditulaire.) after describing the disease, adds, "Phthiriasis olim inter morbos pœnales habebatur, quo extinctos ferunt plurimos. Vide Schenkium, Camerarium, Plempium," &c. and makes a second species, "*Phthiriasis interna: Vermine interne: Phthiriasis funesta.*" In this species the insects issued from the eyes, ears, anus, urethra, and from the orifice made in venæsection. This case terminated fatally.

In conclusion, I would remark that, on touching one of these insects with oil, it was nearly dead in a few minutes: which circumstance would induce me to recommend the trial of such an application for this disease.

Hatton Garden, Jan. 16, 1812. JOHN ANDREE.

VIII. *Reply to Dr.* KELLY's *Letter (see our last Number) on his supposed Discovery of an Error in the Nautical Almanac. By Mr.* FIRMINGER, *late Assistant Astronomer at the Royal Observatory, Greenwich.*

To Mr. Tilloch.

SIR, I SHOULD imagine it is generally understood by the readers of your valuable Journal, that whatever papers appear in that work without signature, or reference to other authors, are either the composition of the editor, from information received by him, or drawn up by persons immediately under his inspection. With this natural impression on my mind I viewed the article in your Magazine for October, entitled, "*On the Error discovered in the Nautical Almanac of* 1812 *by Dr.* KELLY," and conceived you had received the information it contains either from the Doctor himself, or from some other of your correspondents to whom he might have communicated it, and that, when it appeared before the public, the article with respect to its general tenor must be considered as your own. Knowing that this supposed discovery was no discovery at all, but that the Nautical Almanac of 1812 actually appeared in the shape in which its learned author intended it, I was induced to send you an account of such facts as I believed would clearly show the truth of what I have advanced; and I considered I was at liberty so to do, under the form in which your

 article

article appeared, without being thought to have reflected on the character or writings of the supposed discoverer, or indeed on any one else except the editor, whom I wished to correct not only in what regards the notice respecting the Nautical Almanac, but in that which it takes of the French astronomers in their conduct from copying the ephemeris of the Nautical Almanac into their *Connoissance des Tems.* A recent communication has informed me, and must also many others of your readers, that what we take to be written by the editor, may in fact be the production of some other person, who chooses to consider himself offended at any animadversions on his subject, however inaccurate his statements may appear, without declaring such subject to be his own, till after the animadversions had been published. This circumstance we have now witnessed in the conduct of Dr. Kelly, who has thought proper to declare in your last number, that the article above alluded to was his own production; and the reason he gives for the omission of his signature is, that "*it has been considered as a plain, honest, and unassuming statement, that required neither voucher or signature,*" a criterion by which your readers will be enabled in future to distinguish whether the articles they read are the production of the editor, or of a correspondent, to whom they may in some parts allude.

Whatever may be the opinion of the readers of the Philosophical Magazine, respecting the tenor of the article in question, I much doubt whether they will entertain two opinions respecting Dr. Kelly's last communication; they will, I am induced to conclude, consider it as a happy display of egotism, and an unwarrantable abuse of persons who neither knew, nor could be supposed to know, when they were animadverting on articles which appeared in the Philosophical Magazine without signature, that they were actually animadverting on Dr. Kelly's productions; at least I can so speak for myself. But with whatever impressions I wrote my former article, those under which I write this will certainly not be easily mistaken; and since I have been considered by Dr. Kelly as imprudent, I shall take the liberty of freely discussing the merits of his statements.

Dr. Kelly says, that "*neither was the statement dictated in terms likely to give offence, and yet it has called forth two letters in animadversion, which are not of the most gentle tone or texture, and I shall therefore consider them as a kind of partnership production.*" I do not know how far a man may venture to publish his opinions when founded on the wild delusions of his imagination, so as to keep within the

the proper boundary of prudence: but certainly in the present case Dr. Kelly is most completely mistaken; for I can confidently affirm, that Mr. Groombridge knew no more of what I had written on the subject before it appeared in print, than did Dr. Kelly himself. But as the Doctor has allowed me a right, I shall take an opportunity of occasionally referring to Mr. Groombridge's letter, not only because it has been considered a partnership production; but also because, from our long and intimate acquaintance, we have had frequent opportunities of communicating our thoughts on astronomical subjects. It was in one of these communications that Mr. Groombridge noticed to me the discrepancy in the quantity of the obliquity of the ecliptic as contained in the Nautical Almanac of 1812, from those of other years; and my remarks upon it were, that the uncertainty arising from the observations of the Greenwich quadrant were such, as to render the quantity of that datum doubtful to many seconds. In confirmation of this statement, I shall once more call the attention of your readers to the paper which I published in the Philosophical Magazine of December 1810; and although I noticed this paper in my remarks upon the subject in question, I have good reason to believe Dr. Kelly has not given himself the trouble to read it; or, if he has read it, he has not thought proper to notice it, probably in consequence of its militating against his own supposed discovery. I shall therefore copy so much as relates to the present occasion, which runs thus: "If we look to the account given in the Lunar Tables, published by the Board of Longitude in France, we shall find those tables were compiled principally from the astronomical observations made in the Royal Observatory at Greenwich; and not only the epocha, but the present state of diminution in the obliquity of the ecliptic has been in a great measure determined from them. We shall not therefore be surprised to find hereafter a nearer coincidence in the actual state of the ancient observations, and the deductions drawn from theory, when we possess, as we hope soon to do, the means of settling this epocha, and actual state of diminution at the present period. The grand mural circle now making for the Royal Observatory by Mr. Troughton, will, it is expected, be in readiness for observation early in the ensuing year; and we cannot doubt but the first object to be determined with it, will be the settling the above-mentioned data, so essential in the theory and practice of astronomy." If I had not been at the time* above menioned

* Eight months before the paper was published which gave rise to the present communication.

acquainted

acquainted with Dr. Kelly's pretended discovery, is it likely I should have there so particularly noticed the uncertainty in our knowledge of the actual quantity of the obliquity of the ecliptic, as well as of its secular variation? To every impartial reader I think the inference will be evident, without any further declaration on my part, or without my having in that paper pointed out that Dr. Maskelyne had given the obliquity of the ecliptic for the year 1812, from the winter instead of the summer solstice.

What a fortunate circumstance would it have been for Dr. Kelly, had the nature of that communication rendered it necessary for me to have particularly specified the discrepancy in the Almanac of 1812, with either the subsequent or preceding Almanac, in proof of what I had asserted! What a labour would he not have saved! what calculations avoided! and what anxiety for the consequences which the honour of such an important discovery was likely to heap upon him would he not have been relieved from! For notwithstanding all Dr. Kelly has said of his not being influenced by any *motives of vanity*; it is however a pretty strong argument in proof of the contrary, when we find him taking all possible pains to make not only his supposed discovery as much known as he can, but to accompany it with remarks of its vast importance; for can we consider the following sentence in any other point of view: "It was not therefore surprising that in the course of such practice an inaccuracy should be discovered which had escaped the notice of the principal astronomers of Europe!" and also in what other sense can we understand the pains which he has taken to make the subject so generally known? He called on Dr. Burney, and told him of his message to the Astronomer Royal. He wrote to Sir Joseph Banks and Mr. Vince, communicated it to the Earl of Rosse, and in fact it appears he told it to every one he knew; and yet all this was done, we are told, without *vanity!*

In speaking of our letters, the Doctor says, "But notwithstanding *their* manifest disposition, such is the force of truth, that all the leading facts in the [his] statement remain uncontroverted; and, indeed, wholly untouched. *They* allow that an error has been committed in the Nautical Almanac, that the French and American astronomers have copied it, and that *I have discovered it.*"

In what part of the letter here referred to, let me ask, have I allowed that an error has been committed in the Nautical Almanac of 1812? I have shown that Dr. Maskelyne took his obliquity of the ecliptic for that year from the

the observations made with the Greenwich quadrant at the winter solstice; and I have further added, that it is *probable* that the obliquity of the ecliptic for that year might not differ much from what Dr. Maskelyne had assigned it to be in the subsequent Almanacs; but no where have I said it is so. This must be left for Dr. Kelly to decide from observations made with instruments *in his own observatory*, if they exceed in accuracy those at the Royal Observatory at Greenwich; for till we possess more accurate instruments than the Greenwich quadrant, from which this obliquity of the ecliptic was inferred, we must remain in doubt as to its actual quantity. If therefore I am correct in stating, we can prove no error, I must be allowed to deny my having admitted Dr. Kelly to have discovered one. "*They* allow the French and American astronomers have copied it." With as much truth, founded on the same argument, may Dr. Kelly say, that I have allowed not only the French and American astronomers have copied it, but that the Spanish astronomers, the German astronomers, nay, all the world have copied it. In no part of my letter have I mentioned the name or even alluded to the American astronomers. My allowance therefore of their having copied it, or any part of the Nautical Almanac, must rest upon an allowance of my not having contradicted Dr. Kelly's declaration of their having copied it; and the same may be said of all the world, considering that no denial is an allowance of the fact, which I cannot on the present occasion grant; for I must confess that I know not what the American Almanac contains, not having seen one for that year. Dr. Kelly should therefore have been a little more cautious when criticizing on the word *first*, as used by Mr. Groombridge, which I conceive, and intend to show, will bear a better interpretation than he has given it,—that he did not run into error himself by a misapplication of words, which a negligence of reading such letters, or misconception of the subject, had led him to adopt. But how shall we reconcile what the Doctor has just said with what follows,—"but these writers must contradict something, or what was the use or pretence of their letters?" Dr. Kelly says, just before, we have contradicted nothing, and immediately afterwards says, we must contradict something: what interpretation will this bear? That we wished to contradict something, and have failed, or that we have contradicted something? The Doctor must decide this duplicity of meaning. Again, the Doctor says, "*They* therefore volunteer the French cause, and deny at considerable length, that their astronomers pretend to

 original

original computation in the *Connoissance des Tems*, although the contrary is thus stated in the preface to that work. "Les calculs ont été faits, comme à l'ordinaire, sous l'inspection du Bureau des Longitudes, par MM. Marion, Lalande," &c. which in English is this: "The calculations have been made, as usual, under the inspection of the Board of Longitude, by MM. Marion, Lalande," &c.

Suppose a person should say, he has calculated the time when an event will happen at a given place, and it is known that he has derived this calculation from a previous calculation of its happening at another place, by the allowance of some quantity to reduce it from the time at the first place to that of the latter, could this person be said to have calculated such event for the place assigned? If it be allowed that he could under such circumstances be said to have calculated such event for the assigned place, I conceive that what the French have said in the sentence which Dr. Kelly brings as a proof of his assertion, is as applicable to their having, in the compilation of the ephemeris to their *Connoissance des Tems*, taken it from our Nautical Almanac by an allowance of the difference of longitude, as to any other mode of calculation whatever; for surely a man would not say from such quotation, that the French had made their calculations from any one set of tables in preference to another: he would indeed admit their having allowed the calculation to have been made by themselves, but from what tables, or by what means, he could draw no inference; with much less propriety therefore could he undertake to say, that such calculations were declared to be original. Yet this is the language of Dr. Kelly, and in defence of it he has copied the above quotation. It is well known that the French are remarkable for their copious detail. Why have they been so sparing in this instance? The instrument, therefore, which Dr. Kelly has brought in his defence seems rather a stumbling-block in his own way. Dr. Maskelyne has been very particular in the preface to the Nautical Almanac, in describing by what tables, and by what formulæ, his ephemerises are derived. If such description can be found in the French *Connoissance des Tems*, then are we able to say with confidence, that the French have committed themselves or not, according as the case shall appear: but no assurance of this can be derived from the above quotation. I have been here adducing arguments in proof, that, had I said what Dr. Kelly states of me, viz. endeavoured to *show at considerable length that the French do not pretend to original matter*, he has in my opinion brought

brought nothing to contradict it: but the fact is, I have made no such attempts, but quite the contrary, by an allowance that, had the French declared the ephemeris to be originally theirs, I have shown they are declaring nothing more than facts, since it has been from tables of their own computation, that the Nautical Almanac has been in a great measure compiled. I have likewise said, that "*with respect to that part of the statement contained in the Philosophical Magazine, which accuses the French of copying from the calculations of the Nautical Almanac in making up the ephemeris for the Connoissance des Tems; it must be confessed, that if they have declared that those parts were actually calculated by themselves, and not taken from the Nautical Almanac, they are deserving of censure*:" and doubtless, in such case they would be deserving of severe censure, as by that means they would impose on the world circumstances as facts, which are not so. I have further added, that I never saw, or heard any one say they ever did see, such declaration; and I must still affirm the same, notwithstanding Dr. Kelly's quotation, which I cannot conceive in any point of view to contradict it, though, as he says, the names of the computers are specified."

In commenting on Mr. Groombridge's letter, Dr. Kelly seems to catch at a little oversight which that gentleman made in wording his communication, though its true interpretation is easily made out. No person except those who wish to quibble on words, can object to his method of expression in the sense in which he wishes himself to be understood. He plainly objects to Dr. Kelly's statement in being the discoverer, as related to the time of communication, and not to the time in which the discrepancy was *first* observed, as is evident from his saying he had, long before Dr. Kelly's visit to the Observatory, made the subject known both to Dr. Maskelyne and Mr. Pond. But Mr. Groombridge did not communicate this observation of his with such circumstances as should induce these gentlemen to suppose that he considered the *safety of the British navy* as likely to be endangered by it; nor did it, I dare say, ever enter his head, to be at the trouble of calculating new tables of the sun's longitude, right ascension and declination, either for the use of *his own observatory*, or for the use of the public. Mr. Groombridge is a man too well informed on these subjects to consider the discrepancy in question in any other point of view than that of its true point of view, viz. that it is of but little importance to either the astronomer or sailor, whether the Nautical Almanac is computed with an obliquity

obliquity of the ecliptic of 23° 27′ 40″, or 23° 27′ 50″. In saying thus, I do not wish it to be understood that I mean it is but of little importance to the astronomer, whether he knows the actual state of the obliquity of the ecliptic within these limits; I mean only as relates to the use of the Nautical Almanac. Nor do I wish it to be understood that I am giving praise to the merits of Mr. Groombridge, though considered a partner in this concern: his labours are before the public, and from them the public will judge for themselves.

But Dr. Kelly tells us, he should not have noticed either of our letters, had it not been from Mr. Groombridge having stated he pointed out the discrepancy in question to Mr. Pond when he first came into office, adding *that he (Dr. Kelly) can affirm with perfect truth and confidence, that in the month of September last Mr. Pond professed himself wholly unacquainted with any such circumstance;* and yet this gentleman modestly tells us directly after, that Mr. Pond told him that he thought he had heard something about an error in the Nautical Almanac of 1815 or 1816 (he believed). If Mr. Pond had not been told something about this circumstance, is it likely he would have said he had been previously informed of some error? Dr. Kelly can therefore say, that Mr. Pond was unacquainted with it, in no other point of view than that the observations with which this information was at first accompanied, were not sufficient to impress a ready recollection of the circumstance. But had Mr. Groombridge told Mr. Pond he should write to Sir Joseph Banks, and other members of the Board of Longitude, about his discovery, I will engage to say Mr. Pond would not have so easily forgot the subject of the communication. It does not appear, however, that the subject was so completely obliterated from Mr. Pond's memory, that he could not recall it; for it appears that Dr. Kelly's visit was on the 11th of September, and Mr. Pond's communication to the Admiralty, on the 25th; on the sight of which Dr. Kelly might have recalled what Mr. Pond had told him, that something had been previously pointed out respecting some error, and he would have directly inferred from that communication to the Admiralty, the circumstance which Mr. Pond had told him was the one in question, but which he at the time alluded to did not recollect. I cannot conceive it at all surprising that Mr. Pond should have forgotten what Mr. Groombridge had said to him when Dr. Kelly made his visit, as Mr. Groombridge says his communication on the subject in question was

was when Mr. Pond first came into office, five or six months before the time Dr. Kelly saw him. Therefore, unless Mr. Groombridge's remarks had been accompanied with any observations of their importance, it is not difficult to conceive a person, situated as Mr. Pond was in coming into that high office, forgetting such communications made to him in general conversation; and thus I believe the *mysterious and delicate question*, as Dr. Kelly calls it, may be settled without any very great efforts of conception.

The paragraph in Dr. Kelly's letter which immediately follows the insinuation, that either Mr. Pond or Mr. Groombridge had committed themselves by a representation of a case upon which the plain statement of facts would not bear them out, informs us of a circumstance the most extraordinary in his whole letter, and cannot fail to do him great credit in as much as regards his industry as a calculator and his ability at discovery. I will state the paragraph in his own words: "When I first discovered this error, I made numerous calculations to ascertain its extent."

Now, notwithstanding Dr Maskelyne's having stated in the preface to the Nautical Almanac in question, the quantity of the obliquity of the ecliptic used in the computation of that ephemeris, and also given the quantity of apparent obliquity deduced from it, which is put down for every third month throughout the year, opposite the first page in the Almanac; and also given the sun's declination at the two solstices exactly conformable to that obliquity; yet Dr. Kelly makes numerous calculations to see if it be so or not, as if he could not believe what he saw, and it was necessary for him to make calculations, to know whether the figures he there found did actually represent what they stood for. I take it for granted, that most people any way conversant with astronomical calculations, know that the sun's apparent declination at the two solstices is equal to the apparent obliquity of the ecliptic at that time; and if in looking over the Nautical Almanac, any doubt had existed in their minds respecting the quantity of the obliquity of the ecliptic, used in the computation of that Almanac, it is natural to suppose the first inquiry they would make, would be to know if the sun's declination at the summer and winter solstice corresponded with the obliquity of the ecliptic; and they would therefore compare the apparent obliquity as given opposite the first page of the Almanac, with the sun's declination at those solstices; by which they would immediately see whether the obliquity used in the computation of the Almanac corresponded to what had been

been stated to have been used, or whether it did not. If the declination did not agree with the obliquity, it would be a clear proof that some mistake existed in either the assumed obliquity, or the declination computed from it. But in the case in question the declination at the two solstices agrees with the obliquity as it ought to do.

It seems therefore extraordinary, that Dr. Kelly, who "has been for many years in the constant practice of teaching mathematical students to compute the columns of the Nautical Almanac," should not have been aware of this circumstance, and thereby evaded the trouble of making *such numerous calculations*. *It is hard to say* indeed, whether the Doctor's joy arising upon the merit that he conceived would be attached to his discovery induced him to actually make these calculations, or the desire of completing the sentence in order to recommend his book upon Spherics, was the motive for such a declaration; but, perhaps, this inference may appear a little deficient in candour towards the Doctor. Should it be so thought, I can only reply, it is in the Doctor's own way of considering things, as I believe I shall by and by make appear.

Whatever might be the reason which induced the Doctor to make these calculations in preference to the simple comparison of the stated obliquity of the ecliptic with the sun's declination at the two solstices, is perhaps immaterial: it may be of more consequence, in the present view of the subject, to notice the merits of his book upon Spherics, to which our attention has been directed in the latter part of this sentence. We are told, that he believes his "work on Spherics and Nautical Astronomy is the only publication where such calculations are particularly exemplified."

The reader, therefore, would be induced to conclude, from such statement, that this book must be a valuable acquisition to the computers of the Nautical Almanac, that it contains *numerous* examples and illustrations of the method of calculating the various particulars contained in the columns of the Nautical Almanac. Nay, he would fancy he should meet in its perusal, with the methods of computing, not only what relates to the sun, but certainly to the moon, from its being a work of nautical practice, and perhaps of the planets also. But how much would such a reader be diasppointed, if, when he came to read this valuable composition, he should find that not a single example existed in the whole book of such computations! and yet, after all the boasted panegyric on it, not a single example strictly speaking does exist of such computations.

I shall

I shall take the liberty of copying all that I can find in this book, that bears the least relation to them. It is contained in an example at page 125, and is as follows:

"*Example.* On the first of May 1795, the sun's longitude was 1 sign 11° 1′ 44″, and the obliquity of the ecliptic 23° 27′ 51″. Required the rest."

The solution stands as follows:

To find the Declination.

As rad. 90° co. arc				
To sine sun's long.	41°	1′	44″	9·8171947
So is sine sun's greatest declination	23	27	51	9·6000745
To sine present declination	15	9	7	9·4172692

To find the Right Ascension.

As cot sun's long.	41°	1′	44″	9·9396053 co arc
To rad.				10·
So is cos obliq. ecliptic ...	23	27	51	9·9625158
To tang right ascension ..	38	35	51	9·9021211

Here 38° 35′ 51″ turned into time, is 2ʰ 34′ 23″ 24‴, the right ascension in time.

The above calculation is accompanied with the following note:

"See the Nautical Almanac for May 1, 1795. The learner should as an exercise take out the sun's longitude and declination for any other day to find the rest, so as to make his calculations agree with those of the Nautical Almanac."

There are besides the above, two more examples, but these are to find the sun's longitude either from his right ascension or declination; which I have omitted, because the sun's longitude is always calculated as put down in the Nautical Almanac, from astronomical tables which embrace no less than fifteen or sixteen different equations. The apparent obliquity of the ecliptic is also computed from astronomical tables; and from the sun's longitude and obliquity of the ecliptic so found, his declination and right ascension is computed by a simple case of a right-angled spherical triangle.

In the example above given, we are not informed what obliquity of the ecliptic is to be used, mean or apparent, nor are

are we told by what means it is to be come at. By a reference to the Nautical Almanac of 1795, I find the obliquity here given is the apparent obliquity for the 1st of April, and is found opposite the first page of that Almanac.

Although the obliquity of the ecliptic is used in both parts of the example, yet in computing the sun's declination in the first part of that example it is called the sun's greatest declination. The inference from which would be, that the sun's greatest declination was always equal to the obliquity of the ecliptic, notwithstanding that in the same year the difference in the apparent obliquity of the ecliptic is not less than 2″,4. The plain state of the fact is, that Dr. Kelly, in this boasted work on Spherics, has given a bungled example in a simple case of right-angled spherical trigonometry, the data for which he has taken from the Nautical Almanac; and which he now declares to be "the only publication he knows of, where the calculations of the columns of the Nautical Almanac are particularly exemplified." On the modesty of this declaration I leave the reader to form his own opinion, remarking only that, if it be correct, Dr. Kelly's acquaintance with publications of this nature is not very extensive.

I now come to the conclusion of the Doctor's letter; and upon it I cannot help remarking, that it appears to me the highest piece of illiberality of sentiment towards Mr. Pond, that I have ever seen written perhaps against any man; for, if it does not directly, it does indirectly, challenge him with having employed Mr. Groombridge and myself, whom he is pleased to consider as partners, to write in defence of his proceedings, in our reply to the statements contained in the Philosophical Magazine. The Doctor says, "And thus, sir, the question might have remained at rest had not his (Mr. Pond's) mistaken friends imprudently interfered." And again he says, "I want neither auxiliaries nor substitutes, nor shall I hereafter reply to any."

Here is an insinuation founded on mere chimerical supposition, without the most distant facts or circumstance that could possibly lead to such a conclusion. "*Facts, indeed, speak for themselves.*"

With respect to myself, I had neither seen Mr. Pond nor received any letter from him for six months before the appearance of the statements I gave in the Philosophical Magazine; and as a proof that Mr. Pond was totally ignorant of what I had done, I shall now publish, by his permission, a letter he sent me some time after my letter in the Philosophical

phical Magazine appeared in public; which was as follows:

"DEAR SIR,—I think every person whose curiosity has been excited by the supposed error in the Nautical Almanac, must feel much indebted to you for your communication on the subject, which I accidentally met with yesterday in Tilloch's Journal. Your statement is, I have no doubt, perfectly correct, and has, indeed, anticipated the very little I had intended to say, in a note, whenever a new edition of the Almanac shall be called for. I never, willingly, could adopt the supposition that the supposed error ever proceeded from any thing like inaccuracy or inattention, and your explanation has removed the very little doubt I ever had upon the subject.

"I remain, dear sir,
"Very faithfully yours,
"Royal Observatory, Dec. 6, 1811. "J. POND."

I shall conclude, that Dr. Kelly's letter, amongst a vast variety of false conjecture and mistatement, is calculated to do considerable injury to the credit of the Nautical Almanac; but I hope a new edition of that work will not be published till the whole of the former edition is sold off; nay, I think it would be a reflection on the ability and indefatigable care of Dr. Maskelyne to do it, perhaps scarcely allowable to make any alteration in a new edition, unless the facts were established upon which such an alteration could fairly be adopted *.

I therefore trust Mr. Pond will, before he adopts such a measure, fully weigh the circumstances under which our present knowledge of the quantity of the obliquity of the ecliptic has been derived; that he will not set aside the work of so great an astronomer as Dr. Maskelyne, without the best grounds founded on observation to justify his measure; and that he will not suffer the discrepancy between

* I have met with persons who have deferred the purchase of the Nautical Almanac for 1812, under the expectation of the publication of a new edition, which, they were led to believe from the account in the Philosophical Magazine, would soon make its appearance, and no doubt but many more have been influenced by the same expectation. But the circulation of this supposed error in the public Newspapers must necessarily tend to render that class of people to whom the use of the Nautical Almanac is the most important, dissatisfied, producing a doubt on their minds of the accuracy of the calculations composing that work; for the sailor knows not, nor cares not, about the obliquity of the ecliptic; he works by precise rules, which, if they give him his situation, is all he wants. The principles by which it is obtained are immaterial, he wants only faith in the instrument by which it is obtained,

the

the Almanac of 1812, and the two immediately preceding and following that period, to lead him to an adoption of one quantity in preference to the other, because it has been considered inconsistent with itself, and with the deductions of the astronomers upon the continent.

I also trust he will always bear in his recollection, that his learned and profound predecessor never did a thing hastily and carelessly; that whatever was done, was done with judgement and deliberation, and founded on the establishment of the best facts which the existing circumstances could procure; that if errors arose in his work, they were such as were unavoidable, or such as could not be removed by the means which he possessed; and that he always adhered to his own deductions notwithstanding they might vary from established authority, unless the means which gave rise to such authority were in his own opinion superior to those from which his had been derived. A close investigation accompanied with sound judgement, and a positive adherence to his own deductions, were the leading traits in the character of Dr. Maskelyne: they will speak for him more than a thousand flimsy panegyrics: they are the characteristics of a sound and well informed mind.

Yours, &c.

T. Firminger.

IX. *A Reply to some Observations and Conclusions in a Paper just published, in the Second Volume of the Medico-Chirurgical Transactions, on the Nature of the Alkaline Matter contained in various dropsical Fluids, and in the Serum of the Blood. By* George Pearson, *M.D. F.R.S. Physician in Ordinary to their Royal Highnesses the Duke and Duchess of York, and their Household, &c. &c.*

To Mr. Tilloch.

Sir, I was favoured a few weeks ago, by Dr. Marcet, the author, with the above named paper. In it I have the satisfaction to find many of the facts confirmed, and none contradicted, which I have published in the Philosophical Transactions 1809 and 1810, on Expectorated Matter and Purulent Fluids; except with regard to the alkaline impregnations. My experiments informed me that expectorated matters and pus contain potash neutralized by an animal substance, or by an acid destructible by fire. I likewise found, as I prosecuted my inquiries, that there is the same kind

kind of alkaline impregnation in the blood, in the dropsy fluids, in the fluid effused by vesicating with cantharides, in the fluid secreted from the nose owing to a catarrh, and even in the urine. And as I did not find the soda alkali in a similar state, I concluded that hitherto this alkali had, probably, been mistaken for the potash. (See our preceding numbers.) In the ingenious paper, however, which has occasioned this reply, it is asserted that the alkali in combination with the animal matter is the soda; but it is inferred that potash is also present, not in the state I discovered, but united to muriatic acid.

It would not be treating the public justly, if I did not say that the paper before me contains an inquiry conducted conjointly by Dr. Marcet the writer, and Dr. Wollaston; as Dr. Marcet represents, I allow very fairly, to enhance the credit of his statement. Considering the power of these allied opponents, the odds are fearful; but confiding in the assurance of lord Bacon, that induction by experiment equalizes* the mental faculties among different men, I shall with this palladium obey the summons to the arena—at the worst issue, with such adversaries it would be glorious even to fall in the struggle:

——————— agimus proh Jupiter! ———
—— Causam; et mecum confertur Ulysses.

To enable the chemical public to judge rightly of the different conclusions, above declared, concerning the kinds and states of the alkalies existing in the animal fluids, the evidence of the opposing parties must be heard. The adverse party, however, have not attempted to invalidate my evidence, by showing that the conclusions are unjustifiable, but have merely exhibited their own experiments and conclusions. This mode of procedure, I apprehend, is not according to the laws of controversy; and it compels me to make a statement of at least some of the most decisive experiments for my conclusions, previously to the examination of the contravening evidence.

I. 961 grains of exsiccated sputum, on incineration and fusion, afforded 45 grains of saline substances consisting of 35 grains of cubical crystals of muriate of soda, and the rest were spicular and uncrystallized salt amounting to ten grains. These ten grains were separated for distinct examination. They manifested the properties of alkaline mat-

* Nostra vero inveniendi scientias ea est ratio, ut non multum ingeniorum acumini et robori relinquatur; sed quæ ingenia et intellectus fere exæquet.—Bacon's *Novum Organum*, § lxi.

ter. On adding liquid tartaric acid to this alkaline matter also liquefied, an effervescence ensued, with a precipitate of super-tartrate of potash only; "*certainly yielding no soda-tartrate of potash.*" With nitro-muriate of platina a grain or two of this saline matter produced a reddish precipitate. Now if muriate of potash, and carbonate or sub-carbonate of soda had existed, the result must have been soda-tartrate of potash and muriate of soda; or tartrate of potash and muriate of soda. This latter result is not so probable as the former, on account of the very large proportion of alkali to any other possible salt. The quantities, too, were obviously sufficient for producing compound salts determinable by the eye unassisted with glasses.

II. By digesting 2500 grains of desiccated sputum in four pints of alcohol of spirit of wine, the clear tincture decanted from off the undissolved matter afforded on distillation 140 grains of resin-like substance; which manifested no alkaline properties, but it indicated slightly acidity.

A portion of this resin-like substance being mixed with liquid tartaric acid was subjected to distillation; but neither muriatic nor any other acid was disengaged. This I conceive shows that no muriate of potash existed.

Twenty-five grains of this matter were acted upon by successive affusions of nitric acid; and on boiling to dryness and ignition, the deflagration which took place produced a charcoal-like mass containing potash. Hence the alkali had been united to something destructible by fire.

According to computation, the 140 grains of resin-like matter contained 28 grains of potash united to matter destructible by fire, and 18 grains of muriate of soda, with an inappreciable quantity of ammonia and phosphoric acid besides the animal matter. The matter undissolved by alcohol, in this process, afforded by incineration and fusion a mass consisting of 23 grains of muriate of soda with a very small proportion of potash mixed with 23 grains of phosphate of lime, traces of magnesia, iron, and a sulphate; also a minute portion of utterly indissoluble vitrified matter. If potash had existed in union with muriatic acid, it must have appeared in the fused mass left undissolved after digestion in alcohol: but potash did appear in a naked state after ignition and fusion of the matter dissolved in alcohol.

III. By digesting 4000 grains of sputum in two pints of rectified spirit of wine, the same results were obtained, excepting that the resin-like matter contained a much larger proportion of muriate of soda and animal matter.

IV. Twenty ounces of ropy sputum by digestion in ten

pints

pints of distilled acetic acid afforded, by evaporation of the clear liquid separated from the coagulated matter, a soft extract. This extract deliquesced, partially, on exposure for a few days to the air; but it manifested no properties of alkali. By exsiccation, ignition, and fusion of a little of this deliquesced matter, it afforded an aqueous solution which precipitated abundantly super-tartrate of potash on adding tartaric acid; and a reddish precipitate fell on the addition of platina solution. Almost the whole of this extract being exsiccated was digested in rectified spirit of wine, affording a blackish tincture after evaporation to dryness, which became liquid by 24 hours exposure to the air. It was almost entirely acetate of potash. I believe acetate of soda neither dissolves in alcohol nor deliquesces; but, independently of these properties, the alkali united was proved to be potash.

I shall call no other evidence from a great mass which remains in my published papers. If I were to follow the example of my adversaries, I should also not trouble myself to examine their evidence; but as the question cannot be decided without such an examination, I beg permission to perform this duty.

I. *Of the Fluid of the Spina bifida.*

In the ten printed pages of experiments on this fluid by Dr. Marcet, I can only perceive that there is evidence for the existence of an alkaline subcarbonate; yet it is said, "Soda may be inferred from the effervescence with acids." The alkaline matter was treated with alcohol; and thus it was separated from the muriate. The alcoholic solution being decanted and evaporated to dryness, a residue supposed to consist of acetate of soda was obtained, which weighed between 17 and 18 per cent. of the mass." Oxymuriate of platina produced no precipitate.

I remark, that the first result only shows the presence of charcoal acid. 2. The acetate of soda is not, I believe, dissoluble in alcohol, but it is well known that acetate of potash is so. However, if there be the authority of experiment for the dissolubility of acetate of soda in this menstruum, still the experiment is equivocal. It was easy for the adverse party to have decided this question by the test of tartaric acid, provided there was an adequate quantity of matter for the trial.

3. I remark, that there being no precipitation with the platina solution seems to me to prove nothing; as the whole quantity of matter treated could not reasonably be

 supposed

supposed to amount to more than a small fraction of a grain; too small for the detection of potash by means of the platina solution, or even probably by the more sensible test tartaric acid, which was not used. Yet the ingenious writer has not only inserted soda among the impregnating ingredients of the fluid under examination, but also boldly denoted the proportion to the centesimal part of a grain. I shall in another part of this communication, I believe, demonstrate that this analysis does not warrant the statement of the composition of this dropsical fluid given in such precise terms: for, on the ground of cogent analogy, I cannot doubt that one or more ingredients are present, but not inquired for by experiment, nor enumerated. Hence, not only is the analysis objectionable with respect to the ingredients but the proportions. It is true, in a subsequent part of the investigation the deficiency seems to have been perceived and acknowledged; but if so, it will not be an easy task to justify the publication of perhaps an inaccurate analytical statement, in opposition to my experiments which have not been refuted.

II. *Of the Fluid of the Hydrocephalus internus.*

A few grains of the saline matter of this fluid consisted of cubic crystals mixed with spicular and opake globules. The assertion is several times made, that the spicular crystals and opake globules were carbonate of soda—that most of the cubes were muriate of soda; but some of the smaller ones were found to be muriate of potash. The proofs for the assertion are from the two reagents I employed in the same inquiry; namely, tartaric acid and platina solution for the potash; and " the carbonate of soda was identified, not only by tests indicative of the absence of potash, but also by its forming rhomboidal instead of prismatic crystals, when treated with nitric acid."

Now, I apprehend our judges will deem this evidence unsatisfactory; and that much more decisive proofs will be reasonably expected. I beg permission to ask, whether or not the laborious experiments upon a large scale, which I instituted, to exhibit evidence of the exclusive existence of the potash alkali, are to be disproved by the rhomboidal figure of the crystals, in place of prismatic, seen perhaps only by a magnifying glass in the quantity of a grain or two dispersed over a comparatively extensive surface; and whether or not the absence of potash, indicated by tests operating upon minute quantities, is unequivocal evidence, and ought to counterpoise experiments, with quantities af-

fording

fording products, of which no doubt can be entertained, I do not question the accuracy; but I hope it is proper to take a further objection against the competency of the experiment asserted, for the presence of soda and absence of potash. On the most important point which occurred in the inquiry, the kind of alkali existing in the fluids, I do conceive that more experiments, and particularly detailed, are necessary to effect the dis-proof of what I have published, and to command assent, that soda and not potash is present. Is it satisfactory to affirm, that soda was identified, because the tests did not indicate potash? It is quite superfluous for me to say to such learned adversaries as I have the honour of addressing, that an experiment might have been instituted to have afforded unquestionable proof of the existence of soda. Such a proof would be the composition of a binate salt, possessing the known properties of a compound of soda and the acid employed.

With respect to muriate of potash, that this is present, is supported only by the observation of smaller cubic crystals among larger ones; otherwise it is a mere assertion.

My last argument is of a different kind from those above stated. If carbonate of soda in a large, and muriate of potash in a small proportion be present, on the addition of tartaric acid, it is obvious that it is scarcely possible to avoid compounding soda-tartrate of potash, and certainly muriate of soda. If the learned opponents had produced these compositions, I must have conceded, at least, that carbonate of soda existed; but still it would require other experiments to determine the state of the potash.

3. *Of the Fluids of Ascites, Hydrothorax, and Hydrops Pericardii.*

A saline mass amounting to 4·8 grains, obtained by the processes above mentioned, exhibited clusters of crystals, partly cubic, partly octohedral, interspersed with others of a feathery or radiating appearance. The feathery saline matter effervesced briskly with acids, and yielded no permanent precipitate, either with tartaric acid or with oxymuriate of platina. The cubic crystals and octohedral yielded precipitates with either of the two tests just mentioned.

I do not conceive that these observations authorize the adverse party to contravene my experiments and conclusions. I know from experience, that it is probable the feathery crystals even of potash would elude detection, on account of the minute quantity; there was however a pre-

 cipitate,

cipitate, but not permanent. The question naturally arises, What was that non-permanent precipitate? I have no doubt the quantity was too small to enable the question to be answered even by the hands that performed the experiment.

But the cubic and octohedral crystals yielded precipitates with either of the two tests; and hence potash is inferred to exist united to muriatic acid. I again must appeal to chemical judges, to determine whether or not the conclusion is warrantable; for, 1. Here is no proof of muriate of potash. 2. It is not even certain that the precipitate was supertartrate of potash. 3. Granting that supertartrate of potash was produced, it remains to be proved in what state this alkali subsisted.

4. *Of the Serum of the Blood.*

The saline matter procured from this fluid did not, with the platina solution, "produce a precipitate sufficiently distinct to be conclusive as to the presence of potash; but, by means of tartaric acid, a distinct though not abundant precipitate was produced." Further, with nitric acid this saline matter yielded crystals of a "rhomboidal form." Again: this matter dissolved in acetic acid, being evaporated to dryness, was treated with alcohol and again evaporated: "the residue, contrary to my expectation, exhibited traces of potash; but the same residue, with nitric acid, yielded rhomboidal, and no prismatic crystals were seen;" whilst "potash was easily discoverable in the residue, which had now lost its deliquescent quality." I wish to avoid repetition of objections already offered, although they are applicable in this place, and will only remark: 1. That I cannot admit the figure of such minute crystals, as a decisive property; but the kind of nitrate compounded might have been ascertained by the test of tartaric acid. 2. The dissolution of the acetate in alcohol is the most conclusive experiment given in the paper before me; and it has produced apparent embarrassment. Even as performed it is pretty determinate, and might have become an *experimentum crucis* by prosecuting it a little further. We know that acetate of potash is dissoluble in alcohol, and there is no proof that soda united to acetic acid is present; even if such a compound be dissoluble in alcohol. It has been thought right, however, to assume an hypothesis, or more truly two hypotheses, to account for the potash in the menstruum of alcohol; viz.—1. To imagine that muriate of potash is present. 2. That it is dissoluble in alcohol. If potash

potash was present in the indissoluble residue, it was most important to have exhibited the state in which it existed. It was not difficult to determine, if doubted, the state of the potash in the alcohol, by burning the residue left on evaporation, which would have denuded it if united to the acetic acid, but not if united to the muriatic acid. Supposing it be judged right to receive these experiments as evidence of the facts asserted by the adverse party, I beg to claim the right also of opposing the contravening evidence above delivered, in stating the results of a similar experiment.

From this representation, I submit to our judges, whether or not I am entitled to object to the enumeration of subcarbonate of soda as one of the impregnating ingredients of serum, and especially to the proportion denoted in centesimal parts of a grain, in a mass amounting to seven or eight grains, consisting of seven different substances. Having communicated merely the information of the senses * through the intermedium of experiments, the chemical world will determine whether or not the opposing party have demonstrated errors in observation, or illegitimate conclusions. I am of opinion, that the best founded conclusions are but provisional, and of course, that chemistry has not yet attained the rank of a science, or at least not of a demonstrative science. This opinion seems just, from a retrospective view of the varying states of chemistry during the last hundred years. Many of the theories of the illustrious Stahl were for half a century admitted as demonstrations of the agency of phlogiston. That these doctrines were erroneous, was evinced by the succeeding discovery of the agency of oxygen, especially manifested by the ever-to-be-lamented Lavoisier. And the pneumatic doctrine in some parts has lately been rendered doubtful, if not exploded, by the wondrous achievements of professor Davy. Contemplating the prospect of the progression of this branch of natural knowledge, I offer the conclusion, that potash, and not soda, is the alkali united to animal matter in the fluids I examined, merely as provisional. That potash does also exist in these fluids, united to muriatic acid, is not inconsistent with my experiments; but the experiments of my learned friends do not appear to

* Sensus enim per se res infirma est et aberrans; neque organa ad amplificandos sensus aut acuendos multum valent; sed omnis verior interpretatio naturæ conficitur per instantias et experimenta idonea et apposita; ubi sensus de experimento tantum, experimentum de natura et re ipsâ judicat.—Bacon's *Novum Organum.*

authorize such an inference. The discovery, however, will be partly due to them if hereafter the fact be substantiated.

I cannot close this communication until I shall have said a few words concerning the high encomiums on microscopic chemistry, accompanied by the bitter philippic against "the dismal, large, subterraneous laboratory." Chemistry must now, we are told, be transferred to "the comfortable fire-side of the drawing-room;" from Vulcan's foul stithy to my lady's chamber. This *elegant* change is to give "new impulse to the advancement of the science, and new schools are to arise under new auspices." Most happy shall I be to find these Eutopian prospects realised. It seems, however, more than probable, that the successful impulses already given by the schools of "my very learned and approved good masters," Cullen, Black, and Fordyce, will retain the cultivators in the paths now opened. And with regard to the scene for operations, the privilege of *taste* will be asserted; for that indeed is not disputable either in chemistry or elsewhere. Becher's taste was opposite to that of the ingenious new advocates: "Nec quicquam præ carbonibus, venenis, fuligine, follibus, et furnis valere potest."—*Phys. Subter. Præf.* The lord high chancellor of England not long ago declared in court, that he would not pay *sixpence* for the rapturous notes of Mara or Catalani. This also was a matter of taste, and no one disputed: it was only observed by a large majority, that his lordship had "no music in his soul, and was not charmed by concord of sweet sounds."—No more.

The value of a tree is best known by its fruits: and accordingly to inform the judgement of the public by practical examples; and as some return for the notice with which my papers have been honoured, I shall, with your permission, offer for your next number a few remarks on the publication in general which has produced this communication; in which, whatever differing opinions may subsist, I assuredly must admire the ingenuity, and respect the knowledge, of the honourable antagonists.

George-street, Hanover-square, G. P.
Jan. 14, 1812.

X. *Proceedings of Learned Societies.*

ROYAL SOCIETY.

Jan. 9 and 16. THE conclusion of Dr. Herschel's paper on the late comet was read. The Doctor entered into a very minute investigation of the nature and extent of the luminous

luminous matter which surrounded it at some distance from the planetary body in its centre; this matter he supposed to be of a phosphoric nature; the length of the tail he estimated at an average, about the beginning of October, to be above 100 millions of miles; he described it as very variable both in length and breadth, and as being a hollow cone, emitting light on all its sides; the inner side he supposed might illumine the planetary body in a manner somewhat similar to that in which the ring does Saturn. The planet which he discovered in the place of its nucleus, he concludes, shines with its own light, and not with one borrowed from the sun. His chief reason for this conclusion, was the extensive dark space which intervened between the cometary envelope and the planetary body. From the great alterations which took place in the nature and dimensions of the tail, he was inclined to conjecture that comets may be formed of nebulæ, that those nebulæ undergo condensation in their approach to our sun, or to some of what are called the fixed stars, and that in process of time they may become regular planets. On contrasting the appearance of the late comet with that of 1807, he was inclined to suppose that of 1811 a much younger comet than the former.

Jan. 23. A paper by Mr. Campion (communicated by Mr. Davy) was read, on the structure of the eyes both of man and birds, particularly in relation to that faculty of the eye which enables it to adjust its focus to the distance of the object. The author examined the different conjectures and theories which have been proposed to account for the circumstance, and explain how the eye can have perfect images of objects at very different distances. It has been generally agreed, that the eye must have some contractile power; but the existence of any organ capable of such a function has never been ascertained. Mr. C. in examining the eyes of an eagle, was led to discover the existence of a small muscle attached to the sclerotica and capable of contracting the eye, in a manner equal to effect the necessary change in the focal distance. The same organ he discovered in some other birds, and hence he inferred that something analogous exists in the human eye. He observed, that images pass before the eyes of maniacs as vividly and distinctly without any sensible objects, as they do over those of some persons from objects within the focal distance of their eyes.

A paper by Count Rumford was also read, on the nature of light. The Count, firmly persuaded that it is of great commercial importance to increase the quantity of light

light for men's use, and that this luminous *nothing* has no more distinct existence than sound, proceeded to make a number of little experiments on wax tapers and a photometer. He began by weighing the combustible matter consumed or transformed during a given time, and compared the quantity of light emitted in proportion to the wax burnt. In nine such experiments he satisfied himself that the light emitted bore no invariable proportion to the quantity of combustible matter consumed, but that with small tapers, which yielded very little light, there was a very considerable increase of heat. Here he was induced to make some observations on the nature of heat, or heated bodies, so far as their luminous qualities were concerned; all of which, he thought, tended to confirm his opinion, that there is no such matter in existence as light, and that philosophers may for ever torture their imaginations about its nature and qualities, without ever being a tittle the wiser. He observed, that no person ever looked for the nature and properties of sound in fulminating powder, and it is equally idle to look for those of light in combustible bodies. He has however a very philanthropic and important discovery to make, namely, a new invention of his *own*, a polyflame lamp, consisting of a number of burners, with wicks flat like a ribbon, and so placed one at the side of another that the air can pass between them, at the same time that they are duly supplied with oil. The flat wicks arranged in this manner, side by side, supplied with oil, and covered with a large glass which rose several inches above the flame, yielded as much light as 40 candles! The Count concludes with expressing his own liberality in thus publishing his discovery, and declares himself ready to give every possible information in his power to any person who may wish to construct such lamps; but modestly adds, that his own is not made quite so well as he could wish, and that his apparatus is still capable of further improvement.

The Society then adjourned over a week, to meet again on Thursday the 6th of February.

ROYAL INSTITUTION.

Mr. Davy's Lectures on the Elements of Chemical Philosophy.

Mr. Davy delivered the introductory lecture on this new course on Saturday, Jan. 25. He stated, that in former courses of lectures he had been in the habit of dwelling more upon the imperfections than the perfections of the science, considering

sidering its state as that of infancy, rather than of maturity; but that he was now happy to be able to say, that the time was arrived when some principles of chemical philosophy at least might be considered as fixed, and some important results anticipated; that it had gained relations to the doctrines of quantity, and its experiments were capable of being submitted to those laws of calculation which cannot deceive, and which had already produced such grand results in their application to astronomy.

That if the substances belonging to our globe are constantly undergoing changes in their forms and their sensible qualities, and one variety of matter is, as it were, transmuted into another, such changes, whether natural or artificial, slowly or rapidly performed, are called chemical. The object of chemical philosophy is to ascertain their causes, and to discover the laws by which they are governed. The ends of this branch of knowledge, said the Professor, are the applications of natural substances to new uses, for increasing the comforts and enjoyments of man, and the demonstration of the order, design, and intelligent arrangements, of the system of the earth.

In taking an extended view of the plan of the lectures, Mr. Davy said, he should first consider the active powers producing the phænomenon of chemical change, and afterwards the substances on which they operate. The expansive power or heat, chemical and electrical attraction, are the great causes of decomposition and combination. In discussing the doctrines of heat, he said he should compare the mechanical hypothesis of its consisting in motion of the particles of bodies with the idea of its being a specific kind.—The first opinion was sanctioned by the authority of the greatest philosophers of this country, is equally applicable to the explanation of the phænomenon, and involves the supposition of fewer unknown causes.—Chemical attraction, he said, he should consider as a definite power, combining bodies in definite proportions, capable of being expressed by numbers. Electrical attraction produced many of the same effects as chemical attraction; and electricity, as exhibited by the Voltaic apparatus, is capable of being made a general instrument of decomposition. Mr. Davy referred to the extraordinary effects produced by this wonderful invention, which, he said, had done as much for the higher departments of chemistry as the air pump for pneumatics, the microscope for natural history, and the telescope for astronomy; and which had not only produced new views in the science to which it particularly belonged,

belonged, but which likewise promised to enlighten the whole philosophy of terrestrial nature.

In treating of the substances which undergo chemical changes, he said, he should first consider radiant or ethereal matter, those which are known only in motion, or by their effects. He said, he should discuss particularly the *polarity* of light advanced by Newton, and confirmed by the late experiments of Malus. The solar rays produce that light and chemical effects, and there is an analogy between the powers of the two solar beams and electricity; and crystalline bodies have certain relations to light, like those of different electrified surfaces; and from new investigations on this subject, the Professor said, he anticipated a more intimate connexion between chemical and mechanical philosophy.

He divided ponderable undecomposed substances into two classes, empyreal and inflammable supporters of combustion and combustible bodies; and from ten different combinations deduced all the phænomena of composition. They unite, he said, according to uniform laws; form definite compounds, generally crystallized, and which may be represented by numbers resulting from the addition of the numbers representing their elements. As in the system of the Heavens, gravitation and the projectile force acting according to constant laws produce the regular and harmonious motion of the planets, so in the terrestrial cycle of events, the repulsive and attractive powers of matter are in uniform operation, occasion a series of events flowing in a happy order, and constantly subservient to the purposes of life.

Mr. Davy concluded his lecture by some observations on the uses of the science, and the advantages resulting from the study. From the earliest æra of society, he said, when metals were produced from rude ores to the knowledge of the bleaching liquor, chemistry had been constantly subservient to cultivation and improvement in the manufacture of porcelain and glass, in the arts of dyeing and tanning, and has added to the elegancies, refinements, and comforts of life. In its application to medicine, it has removed the most formidable of diseases; and as leading to the discovery of gunpowder, it has changed the institutions of society, and rendered men more independent of brutal strength, less personal and less barbarous. There is, said Mr. Davy, a double source of interest in chemistry, that whilst it is connected with the grand operations of nature, it is likewise subservient to the most common pro-

cesses

cesses as well as the most refined arts of life. New laws cannot be discovered in it without increasing our admiration of the beauty and order of the system of the universe—no new substances brought to light without being, sooner or later, applicable to some purposes of utility. The perfection of chemical philosophy is connected, said the Professor, not only with our national riches but with our national glory. All new knowledge leads to new power, and physical and moral science are ultimately connected. An accurate acquaintance with the laws of nature leads to a deeper feeling of the power and wisdom of the Author of nature, and philosophy thus becomes the exalted instrument for connecting faith and reason.

XI. *Intelligence and Miscellaneous Articles.*

M. Constant, an eminent French chemist, has arrived from Paris, to exhibit a much abbreviated process for making and baking loaf sugar. In one day, he is able to make as much of this article as can be done in eight by the process now in use; and his process has this advantage, that as no animal matter whatever is used, no noxious fumes arise, and the operation may be effected in a common sitting-room.—M. Constant has repeatedly exhibited his process before numerous parties of scientific gentlemen and sugar refiners, all of whom have declared themselves perfectly satisfied as to its practicability and utility; and by their advice he is about to secure his interest in the discovery by a patent.

Mr. Bonnycastle, Professor of Mathematics in the Royal Military Academy, Woolwich, has in the press a new work, which will speedily be published, under the title of "A Treatise on Algebra, in Practice and Theory, methodically arranged in two Parts, and adapted to the present State of the Science; together with Notes and Illustrations, containing a great Variety of Particulars relating to the Discoveries and Improvements that have been made in this Branch of Analysis."

The work will be printed in two moderate sized octavo volumes, and is designed to form the second and third parts of the author's intended general course of mathematics, of which several of the succeeding branches are nearly ready for publication, and will be sent to press as soon as they are finished.

LIST

LIST OF PATENTS FOR NEW INVENTIONS.

To Frederick Albert Winsor, of Shooter's Hill in the county of Kent, esq. for a method of employing both raw and refined sugars in the composition of sundry articles of merchandize, in great demands, where it has not heretofore been used. Dec. 4, 1811.

To John Hudson, of Cheapside, London, paper-hanger, for a new composition for printing or painting on paper, linen, stuccoed walls, and boarding for the purpose of ornamenting the walls and ceilings of rooms. Dec. 9.

To John Elvey, of the city of Canterbury, millwright, for improvements upon a winnowing machine. Dec. 16.

To John Sorby the younger, of Sheffield in the county of York, shearsmith, for a method of making sheep or wool shears, glovers shears, and horse shears. Dec. 19.

To Robert Webster, of Mount Fields, in the parish of Saint Chadds, Shrewsbury, in the county of Salop, for his improved portable mangle.—13th Jan. 1812.

To William Nicholson, of Bloomsbury-Square, in the county of Middlesex, esq. for certain improvements in the method or manner of supporting or suspending the bodies or principal parts of wheel carriages.—13th Jan.

Metereological Observations made at Clapton in Hackney, from Dec. 20, 1811, *to Jan.* 20, 1812.

Dec. 20.—Small rain continued through the day; windy by night from S.W.

Dec. 21.—Cloudy, windy, and hazy, followed by some rain. W.

Dec. 22.—Early the sky was quite clear; afterwards various features of *cirrocumulus*, *cirrus*, and *cirrostratus*, in different heights: towards evening the quantity of cloud much increased, but the night became clear: a coloured *corona* frequently appeared about the moon. Wind N.E.

Dec. 23.—Cloudy morning; afterwards fair with various clouds; by sunset it was clear; there was a crimson blush all around, while the western hemisphere appeared of a bright golden colour. W.N.W.

Dec. 24.—Cloudy, calm and hazy day.

Dec. 25.—Clear day, save a few light clouds; in the evening features of *cirrus linearis*, &c. Wind N.

Dec. 26.—Clouded sky, and strong white frost on the ground; clear night, with *linear cirri*. N.

Dec. 27.—Cloudy, cold, frosty and foggy morning; afterwards some snow and rain; various flimsy clouds by night.

Dec.

Dec. 28.—Cold, raw, unpleasant day: some snow fell in the afternoon.

Dec. 29.—Clouded over nearly all day; the moon appeared through thin clouds by night; a thick coat of snow lying on the ground. N.

Dec. 30.—Clear morning; afterwards much cloud. Wind N.

Dec. 31.—Very cold cloudy day; warmer in the evening. Wind N. and S.W.

Jan. 1, 1812.—A complete thaw; a foggy morning followed by a cloudy wet day and clear night. Wind S.W.

Jan. 2.—Various lofty *cirri* followed by showers. S.W.

Jan. 3.—Showers, and various clouds in the intervals; windy by night from the S.

Jan. 4.—Foggy and calm morning, with S.W. wind; in the evening raw unpleasant wind from E.

Jan. 5.—Snowing all the morning; raw afternoon. N.

Jan. 6.—*Cirrus* and *cirrocumulus*: cloudy afternoon. N.W.

Jan. 7.—Snow fell before light; day cloudy at intervals. Wind N.W.

Jan. 8.—Some cumulative masses of cloud in small clusters; then showers of snow. Wind N.

Jan. 9.—*Cirrus* and *cirrocumulus*: dark snowy night. N.E.

Jan. 10.—Clouded and foggy, a very unpleasant thaw.

Jan. 11.—Clouded day and northwest wind.

Jan. 12.—Fair, with various clouds. N.N.W.

Jan. 13.—Clouds followed by long and gentle showers. Wind N.N.W.

Jan. 14.—Cloudy and hazy. Wind N.N.W.

Jan. 15.—Fair day: features of linear *cirrus* coloured at sunset.

Jan. 16.—Calm hazy cloudy day. N.W.

Jan. 17.—Hazy, cloudy and calm. N.W.

Jan. 18.—Much cloud, wind west: the night exhibited some stars.

Jan. 19.—Cloudy and hazy morning, with some small rain: the various features of clouds appeared mixed in different altitudes: followed by much wind with showers, and clear intervals. W.

Jan. 20.—Fair day: numerous *cirri* and *cirrocumuli* at different heights, while *cumuli* sailed under: much *cumulostratus* in the evening. Wind N.

Clapton, Jan. 21, 1811. THOMAS FORSTER.

METEORO-

METEOROLOGICAL TABLE,

By Mr. Cary, of the Strand,

For January 1812.

Days of Month.	Thermometer. 8 o'Clock, Morning.	Noon.	11 o'Clock, Night.	Height of the Barom. Inches.	Degrees of Dryness by Leslie's Hygrometer.	Weather.
Dec. 27	25	33°	32°	29·03	0	Snow
28	30	33	30	·24	0	Snow
29	30	32	25	·56	0	Cloudy
30	25	32	26	·96	0	Fair
31	26	32	33	·98	0	Cloudy
Jan. 1	35	42	33	·76	6	Fair
2	40	46	36	·50	10	Fair
3	36	43	35	·20	0	Rain
4	32	39	33	·39	5	Cloudy
5	33	33	36	·15	0	Snow and rain
6	30	37	33	·70	4	Fair
7	33	36	35	·62	0	Snow
8	33	37	32	30·04	7	Fair
9	29	33	33	·12	0	Snow
10	33	34	34	·10	0	Rain
11	34	37	37	29·87	0	Cloudy
12	35	38	35	·87	6	Fair
13	34	39	37	·90	4	Cloudy
14	37	42	36	·99	6	Cloudy
15	36	43	32	30·10	10	Fair
16	32	42	40	·16	0	Foggy
17	39	41	36	·18	0	Foggy
18	37	46	40	·11	5	Cloudy
19	43	47	43	·05	5	Cloudy
20	38	44	34	29·90	11	Fair
21	32	37	32	·91	12	Fair
22	32	35	33	·80	4	Cloudy
23	31	33	32	·91	6	Fair
24	32	34	29	30·01	10	Fair
25	30	43	43	29·99	9	Cloudy
26	43	46	40	30·01	6	Cloudy

N.B. The Barometer's height is taken at one o'clock.

ERRATUM.

In page 441, line 1, of our last volume, instead of *for* the last two years, read *previous to* the last two years.

XII. *On the Localities of certain Reliquia, or extraneous Fossils, found in Derbyshire. By the late Mr.* William Martin, *F.L.S. &c.*

To Mr. Tilloch.

Sir, In the work, which I have recently published on the Petrifactions of Derbyshire*, the localities of the species described are given with as much exactness as appeared to me, at the time of writing, necessary for the general information of the student and collector of these bodies. Thus, in the first part of the volume, I have constantly noted the mineral *tract* and usual *geographic situation*† of each fossil, as, "common in *limestone* near *Buxton*;"—"found near *Chesterfield*, in beds of *argillaceous ironstone*," &c. And in the second part, which contains the systematical arrangement of the species, I have been more particular in pointing out the nature of the *seat* in which the petrifaction has been found, as "Sedes: strata vetusta, calcaria."—"Sedes: strata vetula, argillacea, ferrifera," &c. &c. It has occurred to me, however, since the volume was printed, that something more might have been added, with advantage to this part of the undertaking; and that, in a *geological* point of view, notices of the particular situations, (*loca specialia*,) as well as of the immediate stratum, in which the fossil has been discovered, will be found useful appendages to the specific diagnosis, or general description of the species. All, who have attended to extraneous fossils *in the field*, as well as *in the cabinet*, must have observed, that the different species, as I have elsewhere remarked ‡, abound in particular Rocks, especially of those which are properly denominated petrifactions, and though not wholly confined to, are more common in, particular strata than in others, though of the same substance and constituting a part of the same *soil*, or series of mineral beds: thus in Derbyshire the shells, corals, &c., which abound *in the first limestone stratum*, or that which immediately follows the shale tract, are by no means frequent *in the second limestone*, or that which lies under the first toadstone. Nor are the petrifactions of the *second limestone* common to the *first* or third, &c.; though all these strata are evidently constituent parts of the same formation. Again, in the *coal soils* of this county the constituent strata of gritstone, ironstone, shale, &c. may all, I think, be characterized by their respective vegetal fossils. That much practical utility in geology and mining might be the result of this circumstance, when the different species of

* *Petrificata Derbiensia*, or Figures and Descriptions collected in Derbyshire.

† For the particular sense, in which these terms are here employed, I must refer to the "Outlines," &c. pp. 155. 181.

‡ Outlines, p. 9.

extraneous fossils are properly, that is, scientifically* discriminated, has long been my own opinion; and this opinion has been abundantly confirmed by a conversation I have lately had with your most ingenious correspondent Mr. J. Farey, whose knowledge of the stratification of this island is unquestionably great. This gentleman has well pointed out to me the utility as well as the practicability of distinguishing the various strata in a soil, or series of strata, by their *organic contents*. And I regret, that in the first volume of the publication above mentioned I have not paid more particular attention to this point; that is, not only by noting the *immediate stratum* (whenever I have ascertained it), in which the species has occurred, but also the particular situations (*loca specialia*) where it is to be found; as these in many instances would give others an opportunity of determining the immediate, where I have only been able to speak as to the general *soil*. In the second volume of the work in question, which I am now preparing for the press, it will be my aim to give the geological as well as the geographical situation with more precision. The following additional remarks to the localities, enumerated in my first volume, may not only be useful to the purchasers of the work, but also induce geologists to pay some attention to a subject, that has been hitherto so much neglected. I am, sir, your obedient servant,

WILLIAM MARTIN.†

* I hope that geologists will not in future be content merely to say, that such a rock "abounds in Belemnites, Terebratula, Echinites, &c." or that such a formation of strata "contains Ammonites, &c." Such information can be of little use, unless the species are well characterized. This, in many instances at least, may be done with accuracy; and it is evident, that almost every practical inference that is to be deduced from a knowledge of reliques, will depend in a great measure on their being *specifically* distinguished.

† [On an application to Mr. Farey, and a reference to his Correspondence with the able and lamented Author of this Letter, it appears, that the draft of it was prepared between the 17th of July and the 7th of August 1809, although only part of the first page seems to have been transcribed by Mr. M. in the copy lately sent to me by his Friends: which suspension and delay, seem to have originated in the wish that Mr. M. had, first to avail himself of the information to be derived from the manuscript Mineral Map and Section of Mr. Farey's, since mentioned in the Note p. xxi. of the Preface to Mr. F.'s Derbyshire Report, vol. i. and on which account also, he countermanded a Section that had been engraven (before he knew Mr. F.) and suspended his other proceedings with respect to the promised *Supplement* to the 1st vol. of "Petrificata Derbiensia," (as appears by his Letters to Mr. F.), but unfortunately, he did not continue in health or live to receive the Map and Section alluded to. I have thought these particulars might be worth stating respecting this worthy man, in addition to the *Memoirs* of him in the "Monthly Magazine", for January last, vol. xxxii. p. 556. I have availed myself of Mr. Farey's assistance in three or four corrections or suggestions (in parenthesis) as to the identity of particular strata; and I gladly embrace this opportunity further to mention, that Messrs. White and Cochrane, in Fleet-Street, who continue to sell Mr. Wm. Martin's two works on extraneous Fossils for the benefit of his Widow (in a poor state of health)

Localities, &c. with Remarks.

Oak-like Woodstone. *Petr. Derb.* Tab. 1. Gravel-pits, water-courses, fissures in the limestone strata. I observed some years back small masses of this substance in a gravel-pit half a mile S.E. of Ashburne. As these masses did not appear to be rounded, or water-worn, the gravel was probably their original bed. About four years ago my friend, the late Mr. S. Buxton, surgeon, showed me some specimens of woodstone, which a miner had brought him from a level near Castleton, but I could not find the man, to learn the particular place. The other localities in the Petr. Derb. are given on the authority of Mr. W. Watson of Bakewell.

Even-jointed Entrochite. *Petr. Derb.* Tab. 2. fig. 1. &c. Convex-jointed Entrochite. T. 4. f. 9. Warted Entrochite. T. 4. f. 10. Ring-jointed Entrochite. T. 4. f. 11, 12, 13. Under beds in the first limestone stratum. Near Monyash, &c. In Derbyshire Petrifactions I have stated, that the Entrochitæ occur more or less throughout our limestone tracts. This remark, though perhaps literally true, ought to have been given with certain limitations. The great mass of Entrochal remains, found in Derbyshire, belongs to our first limestone, and, I believe, chiefly characterizes the lower beds of that stratum; yet none of the other lower strata, constituting what may be called the great *ancient* limestone tract*, are wholly destitute of Entrochites, as far as my own observations have extended. I have found Entrochites in the second limestone in beds of dunstone, east of the Clump of Firs on Masson Low near Matlock, in the rock at the back of the old Hall, at Matlock Bath: and in the third limestone stratum, in a small quarry near Buxton, between the Lover's Leap and the Ashburne road (3d or 4th stratum?); in the quarries near Hasling-House, on the right hand of the road from Buxton to that place (3d stratum ?). I have memorandums, which note my having found Entrochites in the 4th limestone, between Bakewell and Buxton, and on

six orphan Children and an aged Mother, also receive the contributions of the humane Friends of departed worth and scientific abilities, towards alleviating the sufferings of those who were most dear to the deceased ; and that Wilson Lowry, Esq. the Artist and Mineralogist, of No. 57, Great Titchfield-Street, Oxford-Street, continues his philanthropic endeavours in the same cause, and will gladly receive and transmit Subscriptions to the Family of the late Mr. Martin at Macclesfield in Cheshire.—Editor.]

* I have not yet sufficiently examined the *less ancient* limestone, (yellow lime,) which appears at the NE corner of the county, to speak positively as to its organic contents.

the right of the road from Buxton to Ashburne; but, as these were made many years back, I cannot speak with certainty as to the particular quarries, where these remains were observed. In all these instances, however, it was only the even-jointed and ring-jointed Entrochites that were noticed.

Since the first volume of Derbyshire Petrifactions was published, I have had a considerable quantity of loose Entrochites sent me from Matlock, got, as I understand, on the surface of the first limestone?, near a vein of Calamine. This is probably the case, as many of the specimens are filled with that substance. Among these *reliquia vaga* are several, which have not before been known as Derbyshire Fossils, viz. an *oval-jointed Entrochite*, figured by Mr. *Parkinson*, *Org. Rem.* vol. ii. T. 13. f. 32. 40, 41.; the *pyriform Entrochite*, *Org. Rem.* vol. ii. T. 16. f. 1, 2, &c. A *doliform-jointed Entrochite*, one of the joints of which is figured *Org. Rem.* vol. ii. T. 13. f. 63: and one or two others, which have not hitherto been noticed by authors.

Conchyliolithus Pinnites *nudus*. *Petr. Derb.* T. 6. f. 1. In the first limestone at Buxton, in a stone wall near the remains of the old Roman Bridge, on the left of the road, leading to Fairfield. I have not yet observed it in any other strata than the first (3d Limestone?).

Conchyliolithus Helicites *Catillus*. T. 7. f. 1, 2. In shale, and first and second limestone. Limestone shale, Buxton, in the foundation of the Shakespeare Inn. First stratum of limestone, Buxton, in the limestone, behind the Shakespeare Inn (3d stratum?); 2d stratum? near the rocks south ½ mile (3d or 4th stratum?).

Spherical Nautilite. T. 7. f. 3, 4, 5. First stratum, Buxton. Rock above the toadstone, left of mill-dale road to the Lover's Leap. Second stratum (3d?), as I judge from the appearance of the limestone, forming the matrix of a specimen, brought to me from Castleton.

Sulcated Phytolite, striaticulmis. T. 8: 9. 25. *First* or *Millstone Grit** stratum. Bakewell, Gritstone quarry, east of the town (shale-grit?). Buxton first grit quarry above the Duke's stables (shale-grit?). I have found impressions of it also on the coarse millstone grit, at the back of the plantation, above the quarry just mentioned.

* I call the first stratum of grit, which immediately reposes on the limestone shale, the limestone grit stratum, not because such substance is invariably found where this stratum appears; but because I believe it always passes into the coarse millstone grit, before the coal-soils commence. In many instances, as at Bakewell, Buxton, &c. &c., close and fine-grained building or freestone grit forms the middle beds of this stratum, which still loosens, as it approaches the limestone shale, gradually, into a rough argillaceous gritstone.

Coal-soil. I cannot particularize, at present, the immediate stratum, in which the specimens principally occur, through the coal-measures; but I have had specimens of it in argillaceous gritstone from Alfreton; in ironstone from Wingerworth, and in the coal shale and the coal itself, from near Buxton. I have not yet observed it in that peculiar siliceous gritstone, found in the coal-measures, called by the miners *crowstone*, although this stone abounds with other vegetive *reliquia*.

Phytolithus corticiradix & Phytol. compressiradix T. 9. Millstone grit stratum? Chapel-en-le-Frith. The specimens were found in a wall about $\frac{1}{2}$ a mile from the town, on the Manchester road. I have not ascertained the quarry, from which the stone was brought. Coal-measures, in argillaceous grit; in a small quarry about 1 $\frac{1}{4}$ mile from Leek, a few yards left of the first Toll-bar on the road to Buxton, in considerable quantity (shale-grit?).

XIII. *General Method for determining the Orbits of Comets. By M.* LAPLACE.

[Concluded from p. 49.]

HAVING thus the true perihelion distance, and the true instant of the passage of the comet by this point, we shall conclude from them the other elements in this way.

Let j be the position of the node which would be ascending if the motion of the comet were direct, and φ the inclination of the orbit: we shall have the six following equations,

$$\text{tang}\, j = \frac{\text{tang}\,\varpi \sin \beta' - \text{tang}\,\varpi' \sin \beta}{\text{tang}\,\varpi \cos \beta' - \text{tang}\,\varpi' \cos \beta}$$

$$\text{tang}\, j = \frac{\text{tang}\,\varpi \sin \beta'' - \text{tang}\,\varpi'' \sin \beta}{\text{tang}\,\varpi \cos \beta'' - \text{tang}\,\varpi'' \cos \beta} \ldots . (e)$$

$$\text{tang}\, j = \frac{\text{tang}\,\varpi' \sin \beta'' - \text{tang}\,\varpi'' \sin \beta'}{\text{tang}\,\varpi' \cos \beta'' - \text{tang}\,\varpi'' \cos \beta'}$$

$$\text{tang}\,\varphi = \frac{\text{tang}\,\varpi}{\sin(\beta - j)}$$

$$\text{tang}\,\varphi = \frac{\text{tang}\,\varpi'}{\sin(\beta' - j)}$$

$$\text{tang}\,\varphi = \frac{\text{tang}\,\varpi''}{\sin(\beta'' - j)} \ldots . (e');$$

We may choose ad libitum among these formulæ: but it will be most correct to employ those whose numerators and denominators are greatest.

 Suppose,

Suppose, for example, that we employ the two formulæ (e) and (e'): it is visible that the tangent of j may equally belong to the two angles j, and $180^\circ + j$, j, being the smallest of the positive angles to which it can belong. In order to determine which of the two to choose, we shall observe that φ and tang φ ought to be positive, and thus, sin $(\text{ϐ}''-j)$ ought to be of the same sign with tang ϖ''; this condition will determine the angle j, and this angle will be the position of the ascending node if the motion of the comet be direct; but if this motion be retrograde we must add 180° to it, in order to have the position of this node.

The hypothenuse of the rectangular spherical triangle of which $\text{ϐ}''-j$ and ϖ'' are the sides, is the distance from the comet to its ascending node in the third observation; and the difference between that hypothenuse and v'' is the interval between the node and the perihelion, reckoned on the orbit.

Let us apply these results to the second comet of 1781, whose perihelion distance and instant of passage by this point we have already determined by a first approximation. For this purpose, we shall use some observations of the 9th of October 1781, and 17th of November and 20th of December of the same year: these observations give

Mean time at Paris.

1781. 9th Oct. at	$16^h\ 50'\ 0''$,	$\alpha = 124^\circ\ 27'\ 42''$,
		$\theta = 0^\circ\ 11'\ 40''$,
17th Nov. at	$8^h\ 29'\ 44''$,	$\alpha' = 306^\circ\ 57'\ 32''$,
		$\theta' = 44^\circ\ 17'\ 12''$,
29th Dec. at	$6^h\ 6'\ 30''$,	$\alpha'' = 306^\circ\ 17'\ 59''$,
		$\theta'' = 17^\circ\ 34'\ 25''$,

We have moreover

$$C = 197^\circ\ 13'\ 44'',\quad \log R = 9{,}998864,$$
$$C' = 235^\circ\ 55'\ 43'',\quad \log R' = 9{,}994602,$$
$$C'' = 269^\circ\ 20'\ 35'',\quad \log R'' = 9{,}992748.$$

This being done; we shall form a first hypothesis, in which the perihelion distance will be, as we have found above, equal to 0,958359, and the instant of the perihelion passage took place on the 29th of November, at $18^h\ 10'\ 34''$; we shall find in this hypothesis

$$v = -61^\circ\ 18'\ 3'',\ v' = -18^\circ\ 7'\ 12'',\ v = 29^\circ\ 8'\ 15'',$$

which gives

$$U = 43^\circ\ 10'\ 41'',\ U' = 90^\circ\ 26'\ 18'';$$

we shall afterwards find

$$\text{ϐ} = 77^\circ\ 5'\ 50'',\ \text{ϐ}' = 37^\circ\ 26'\ 37'',\ \text{ϐ}'' = 346^\circ\ 49'\ 52'',$$
$$\varpi = 0^\circ\ 10'\ 34'',\ \varpi' = 18^\circ\ 6'\ 32''\tfrac{1}{2},\ \varpi'' = 27^\circ\ 12'\ 57'',$$

from which we extract

$$V = 42^\circ\ 53'\ 2'',\ V' = 90^\circ\ 9'\ 22'',$$

dividing $\quad m = 17'\ 49'',\ n = 16'\ 56''.$

The series of the values of ζ, ζ', ζ'', visibly indicates a retrograde motion.

We shall afterwards form a second hypothesis, in which, by preserving the foregoing instant of the perihelion passage, we shall increase the perihelion distance by 0,003. We shall find in this hypothesis

$$m' = -33' 53'', \quad n' = -12' 54''.$$

Lastly, we shall form a third hypothesis, in which, by preserving the same perihelion distance as in the former, we shall vary by 0^d 25 the instant of the perihelion passage, which will thus be fixed on the 29th of November at 12^h 10′ 31″; this hypothesis will give

$$m'' = 48' 16'', \quad n'' = 27' 13'';$$

we shall extract from these values the two following equations,

$$3102 . u - 1829 . t = 1069,$$
$$1760 . u - 617 . t = 1016,$$

which gives

$$u = 0{,}881406, \quad t = 0{,}910400:$$

hence we conclude

the true perihelion distance = 0,9609951,

and the true instant of perihelion passage, the 29th of November at 12^h 42′ 46″ mean time at Paris.

In order to ascertain if these elements are very accurate, we may calculate the corresponding values of m and n, and see if they are null or very small: now we shall find that in the present case these values amount only to a small number of seconds; for the corrected elements give, for instance, for the first and last observation,

$$v = -60^\circ 56' 37'', \quad v'' = 29^\circ 19' 22'',$$
$$\varpi = 10' 33''\tfrac{1}{2}, \quad \varpi'' = 27^\circ 11' 56''\tfrac{3}{4},$$
$$\zeta = 77^\circ 2' 22'', \quad \zeta'' = 346^\circ 38' 53'';$$

from which we extract

$$U' = 90^\circ 15' 59'', \quad V' = 90^\circ 16' 3''\tfrac{1}{2},$$

and consequently $m = -4''\tfrac{1}{2}$. These elements being very accurate, we shall extract from them by means of the formulæ (e) and (e') the position j of the ascending node, and the inclination of the orbit, and we shall find

Place of the ascending node = 77° 22′ 55″.
Inclination of the orbit = 27° 12′ 4″.

In order to determine the place of the perihelion, we shall observe that $\zeta'' - j = 269^\circ 15' 58''$, from which we extract 269° 20′ 50″, for the distance from the comet to its node, reckoned on the orbit, at the instant of the third observation: on adding to this distance the anomaly v'' which the comet has traversed by a retrograde motion since its perihelion passage, we shall have 298° 40′ 12″, for the distance from the perihelion, reckoned on the orbit, to its ascending

 node;

node: by adding afterwards to this distance the longitude of this node, we shall have for the position of the perihelion on the orbit, 376° 3′ 7″, or more simply still 16° 3′ 7″. By collecting all these elements, therefore, we shall have for the true elements of the orbit of the second comet of 1781,

Perihelion distance .... 0,9609951.

29th Nov. 1781. Mean time at Paris of the perihelion .... } 12h 42′ 46″

Place of the perihelion of the orbit .. 16° 3′ 7″.

Place of the ascending node .... 77° 22′ 55″.

Inclination of the orbit .... 27° 12′ 4″.

The motion of the comet is retrograde.

The supposition of the parabolic motion of the comets is not rigorous; it is even infinitely little probable, considering the infinite number of cases which give an elliptic or hyperbolic motion, relative to those which determine the parabolic motion. A comet moved either in a parabolic or hyperbolic orbit will only be visible once; we may suppose, therefore, with probability, that comets which describe these curves, if some of them exist, have long ago disappeared, so that nowadays we only observe those which, being moved in re-entering orbits, are incessantly brought back to intervals more or less large, in the regions adjoining the sun. If they have been observed with precision, and the visible arc of their orbits be considerable, we may determine with tolerable accuracy, by the following method, the time of their revolution.

For this purpose let us suppose that we have four excellent observations which embrace nearly the whole visible part of the orbit; and that we have already determined by the foregoing article, the parabola which nearly satisfies these observations. Let v, v', v'', v''', be the anomalies corresponding to these observations; r, r', r'', r''', the corresponding vector radii; take also

$$v' - v = U,\ v'' - v = U',\ v''' - v = U''.$$

This being done, we shall calculate by the foregoing article, with the parabola which nearly represents these observations, the values of U, U', U'', and those of V, V', V''; take therefore

$$U - V = m,\ U' - V' = m',\ U'' - V'' = m''.$$

We shall afterwards vary by a very small quantity the perihelion distance in this parabola; take then

$$U - V = n,\ U' - V' = n',\ U'' - V'' = n''.$$

We shall afterwards form a third hypothesis, in which, by preserving the same perihelion distance as in the first,

we

we shall vary by a very small quantity the instant of the perihelion passage: take in this hypothesis,

$$U - V = p,\ \ U' - V' = p',\ \ U'' - V'' = p''.$$

This being done, with the perihelion distance and the instant of the passage of the comet by this point, found in the first hypothesis, we shall calculate the angle v and the vector radius r, in the supposition of a very eccentric ellipsis; so that by calling e the relation of the eccentricity of this ellipsis to its half great axis, the difference $1 - e$ is equal to a very small quantity, for instance to $\frac{1}{10}$. In order to have the angle v, in this supposition, it will be sufficient to add to the anomaly v, calculated in the parabola, a small angle, the sine of which is

$$\tfrac{1}{10}(1-e).\text{tang}\,\tfrac{1}{2}v.(4-3.\cos^2\tfrac{1}{2}v-6.\cos^4\tfrac{1}{2}v);$$

The new anomaly v being thus known, we shall substitute it in the equation

$$r = \frac{D}{\cos^2\frac{1}{2}v}\left(1 - \frac{1-e}{2}\,\text{tang}^2\,\tfrac{1}{2}v\right).$$

which is the expression of the vector radius in a very eccentric ellipsis: by this means we shall have the corresponding vector radius r. We shall calculate in the same way v', r'; v'', r''; v''', r'''; from which we shall extract U, U', U'', V, V', V''; in this case take

$$U - V = q,\ \ U' - V' = q',\ \ U'' - V'' = q''.$$

Finally, let us call u the number by which we ought to multiply the supposed variation in the perihelion distance, in order to have the true one; t the number by which we ought to multiply the supposed variation in the instant of the perihelion passage; and δ the number by which we ought to multiply the value supposed for $1-e$; we shall form the three equations

$$u.(n-m) + t.(p-m) + \delta.(q-m) + m = 0,$$
$$u.(n'-m') + t.(p'-m') + \delta.(q'-m') + m' = 0,$$
$$u.(n''-m'') + t.(p''-m'') + \delta.(q''-m'') + m'' = 0.$$

We shall have, by means of these equations, the values of u, t and δ, from which we shall extract the true perihelion distance, the true instant of the passage by this point, and the true value of $1-e$. Let D be the perihelion distance, and a the semi great axis; we shall have $a = \frac{D}{1-e}$; from which it is easy to conclude, that the time of the revolution of the comet will be equal to the number of sidereal years expressed by $\frac{D^{\frac{3}{2}}}{(1-e)^{\frac{3}{2}}}$. We shall have as in page

85;

85, the inclination of the orbit and the positions of the ascending node and of the perihelion.

When the arc observed of the orbit of a comet is considerable, and particularly when it extends beyond 90° of anomaly, where the ellipticity begins to become perceptible; it will be desirable that we should have four observations made with all the precision which we ought to expect from modern astronomy, taking care to verify the position of the stars to which we refer the motion of the comet.

Whatever may be the precision with which we strive to make these observations, they will always leave some uncertainty as to the time of the revolution of comets: the most accurate method for determining it, is to compare the observations of a comet in two consecutive appearances: the resemblance of the elements of the two parabolic orbits determined by these observations, will make known the identity of the comet, and we shall have, by the difference of the instants of the perihelion passage, the time of its revolution and its grand axis. It was thus that the period of the comet observed in 1531, 1607, 1682, and 1759, was determined; a period which is a little unequal, on account of the attraction of the planets, as M. Clairaut has shown, by subjecting to analysis the perturbations experienced by this comet from Jupiter and Saturn.

XIV. *Account of some remarkable Cases of Venereal Infection.*

To Mr. Tilloch.

Sir, Permit me to communicate some medical facts which lately occurred in my practice; and as there is not any sufferer upon whom the circumstances can reflect dishonour, or whose delicacy can suffer by the relation, an insertion of the entire matter in your instructive Magazine may convey original information to professional men, and will oblige Your obedient servant,

Robert Healy, M.B.

On the 23d of July 1810, I was requested by a respectable friend to see his wife, who complained of great and general debility, loss of appetite, with violent pain of the head. She was nursing. The child seemed very healthy. She said she was attacked with hæmorrhoids about three weeks after her lying-in, which was on the 11th of May 1810. She had had small glandular swellings in her groins, which had subsided;

sided; had taken no medicine. About the 28th, reddish spots appeared on her arms, and small tumours scattered over her thighs, which disabled her from walking. She complained of profuse perspiration on her breast, particularly at night. I directed the warm bath with alteratives.

August 7th. Notwithstanding the treatment, the symptoms became much aggravated; the reddish spots had spread upon her face. I requested my friend to confess whether he had not contracted the venereal disease; to which he answered in the most solemn manner in the negative.

On the 14th I required a consultation, and met one of the most eminent physicians in Dublin. After examining the patient, he mentioned our suspicion to the mother of the lady, that the disease was venereal. It was deemed advisable to have a surgeon in consultation, and that we should meet the following day. In the evening I visited a patient convalescent from fever, from whom I heard that a Mrs. M. was dangerously ill, not only from a disease which she had contracted at the time of her lying-in, but also from a very sore mouth. On inquiry, it appeared that she was attended in her accouchement by the same gentleman who attended my patient.

On the 15th we met; and that consultation removed every doubt of the nature of the disease; and as she did not receive it from her husband, I suggested to the medical gentlemen that the accoucheur might have conveyed the infection by his hand. That mode was deemed possible, though not very probable; and our opinion to that effect was communicated to the accoucheur.

18th. All that train of misery incident to supposed connubial infidelity, aggravated by the sufferings of a loathsome disease, must have been the fate of my patient, if she and her husband had not had proper mutual confidence and a friendly reliance on my further investigation. I met Mrs. M.'s brother, with whom I was acquainted; and anxious to vindicate the character of my patient, I told him my suspicion of his sister's disease; and asked him, whether I could with propriety mention my suspicion of the disease to Mr. M. He answered in the affirmative, and introduced me to Mr. M. I related to that gentleman the situation of my patient, and requested to know the disease his wife was labouring under, and the time of her delivery. He said she lay-in on the 22d of May 1810, that the accoucheur was treating her at present for cancer in the womb, or a liver complaint. I submitted my opinion that it was the venereal disease, and also that she might have been infected

at

at the time of her delivery, the accoucheur conveying the infection by his hand. He added, he suspected her disease to be venereal, and had mentioned that suspicion to his wife frequently. I was introduced to the lady; and after examining her, I became more confident in my opinion (as there were buboes in her groins). I advised Mr. M. to have a conversation with the accoucheur, as to the nature of the disease. In consequence of this, he (Mr. M.) called a consultation of the same medical gentlemen, with the accoucheur, who met on the 19th. The surgeon before the consultation called me out of the room, and communicated what the accoucheur had informed him of that morning; namely, that he had contracted the venereal disease in his finger in the course of his practice, and had conveyed this disease in that manner. It was deemed advisable, and even indispensable, for the accoucheur to confess that he was the cause of this severe ailment to those ladies; which he complied with by letter, not only to these ladies, but to others who had been diseased in like manner. Meaning to view the subject merely as an instructive medical report, suffice it to say, that upon a full and legal investigation, it was deposed on oath by a medical gentleman, in behalf of the accoucheur, that he had contracted the disease in the course of his practice, about two years previous to the preceding unfortunate event; that he had undergone a complete course of mercury, and used even a larger quantity than is usual, and that he conceived himself incapable of communicating the disease; that previous to that gentleman's attending my patient, a window sash had fallen on his finger, which produced a sore; that this sore became a venereal one, and infected the ladies before he was aware of its real nature. The child of the first lady was weaned on the 15th; afterwards spoon fed, and continued healthy. The other child was transferred about the 19th to a sound healthy nurse. In a month a rash appeared on the head of the child, which in a little time spread over the body, and remained anomalous for a month, but afterwards became distinctly syphilitic, and which yielded to the influence of mercury. Since the occurrence of the above, I was called to attend a lady, who after exposure to cold complained of acute pain of the right side, shooting to the scapula, causing difficult and impeded respiration; cough and thirst urgent, want of appetite, tongue foul and blackish, pulse quick. She never was confined by sickness, or stood in need of medicine. Married four months. These febrile pulmonary symptoms yielded in a week. After three weeks, I was again requested

to

to see this lady. She now complained of sore throat with difficult deglutition. On inspection, there appeared slight inflammation of the tonsils extending to the palate, which continued stationary about a fortnight, without any other symptom of disease; when, during the use of the warm bath and gentle diaphoretics, venereal blotches on the forehead and nodes on the shin bones arose. It appeared on investigation, that the lady had contracted the disease from her husband, who had had the disorder previous to his marriage, and who had been apparently though not radically cured. Relating this case to an eminent surgeon, he mentioned that a patient of his, a lady, who had contracted the venereal disease in her accouchement from the above mentioned accoucheur, had no other symptom but what first showed itself in the throat.

No. 1, Clarendon Steet, Dublin, Feb. 1, 1812.

XV. *Geological Observations, in Correction of and Addition to the Paper on the Great Derbyshire Denudation, in our last, and the Report on Derbyshire, &c.; relating principally to Coal-measures near to the Chalk Strata; the Course of the 3d and 4th Grit Rocks and Crowstone through Yorkshire, and the Termination of its Coal-field Northward: the Limits of the Yellow Lime Rock, and the Existence of Red Marl, Gypsum Beds, Strontian, &c. between its Rocks, &c. &c. By Mr.* JOHN FAREY *Sen.*

To Mr. Tilloch.

SIR, WHEN the paper which you have done me the honour to copy from the Philosophical Transactions, into your last Number, p. 26, was sent to Sir Joseph Banks, but two or three sheets of my Derbyshire Report had been printed: since which period, by the many comparisons of my travelling and other notes and mineral maps, during the printing of that volume, from the letters and communications of my friends, and two journeys which I made into Yorkshire since the Report was published, some new lights have been thrown on the north-eastern part of the great *Derbyshire Denudation*, the particulars of which I am anxious to submit without delay to your geological readers, in the hope, that some of them will be able and disposed freely to communicate new facts, and verifications or corrections of those which I have already, or am now about to mention, in order, that the remaining difficulties, with

with regard to the stratification of this important part of England, may be cleared up.

When I said (p. 27 and 28 of your last Number) that an uninterrupted series of basset-edges of strata, dipping to the SE, and ranging in continuity from SW to NE in certain undulating lines conformable to the surface, "from one sea to the other," had been traced by Mr. Smith, and shown on his manuscript maps, I spoke from an imperfect recollection of some parts of his maps, and had forgot some difficulties which he once mentioned having experienced, in tracing the strata across the flat country around York: at which time also, he was in the habits of mentioning the oalite or ova-formed limestone of the Bath series and of Portland island in Dorsetshire, as belonging to the same stratum; and as the late Rev. Mr. Michel also considered them, as I have mentioned, p. 103, of your 36th volume, and vol. i. p. 113, of my Derbyshire Report, but which now appears to be incorrect; and that the oalite of St. Alban's-Head and Portland-Isle on the south coast, is the same with that of Calne in Wilts, Aylesbury in Bucks; and New-Malton, Helmsley, Kirby-Moorside, Pickering, and Filey head SE of Scarborough, in Yorkshire, and is situate within 100 yards (perhaps, and composed principally of chalk-marl) of the bottom of the chalk, greatly above the Bath-freestone*: and it seems, that besides the disappearance of the upper of these important Oalites (the Aylesbury Limestone) under Alluvial Clay, from Stewkley in Bucks, through all Bedfordshire, (see that article in the Edinburgh Encyclopædia,) and Cambridgeshire also, perhaps, till its first exit from the Island near Hunstanton-cliff in Norfolk, it makes no appearance, or where the lower Chalk again enters the Island near Wainfleet in Lincolnshire, or for some distance after the bottom edge of the Chalk emerges from the Fens near Walton, as we proceed north-westward; yet, in the hills near Dalby, Langton, &c. I saw thickness enough of strata basseting, to account for this Limestone Rock, that I had not time to search for minutely, or to inquire what had been proved underground, in sinking wells or otherwise, when I was in that county in 1807,

* Do more than these *two* parts of the British series of strata produce *ova-formed limestones*? a question I ask of your correspondents, from having seen a very flat Echinus filled with oalite (like those of the Bath strata) said to be brought from Linton-Swinden in Threshfield, ten miles N. of Skipton in Yorkshire? The large botryoidal Pisolithus at Boiling-hill one mile S. of the mouth of the Wear in Durham, and in other situations, do not appear to compose regular strata, I believe, as the small pisolites do.

Mr. Michel's "very fine white sand," vol. xxxvi. p. 104, seems to be that dug at the foot of the red marl range, on Markham-Moor, by the great North Road.

nor can I hear any thing more of the appearance of this Oalite, near to Market-Raisin E, Caiston W, Brigg E, crossing the Humber NW of Barton, near Market-Weighton W, and near Pocklington, where I suppose to be its range, and on which points I solicit the assistance of your readers and correspondents.

The first or outer-raised tract shown in the map and mentioned p. 30, of your last Number, I now suppose to have a north-eastern corner extended to near Leavening, between Acklam and Burythorpe, near to the edge of the Chalk! ; the eastern boundary *fault*, after passing W of Bawtry and Thorne, as there mentioned, probably proceeding near Snaith, W of Howden, E of Aughton, W of Pocklington, W of Garraby-street Inn on the York and Bridlington Road (being here very near to the Chalk), near Acklam ; and after turning nearly at right angles near Leavening, the same probably proceeds near Crambe S, Sheriff-Hutton S, Stillington S, Easingwold, Thirsk SW, to near the Swale River about Ainderby-Steeple, where I suppose it to turn again at rather more than a right angle, pass NW of Northallerton, NW of Stokesley, near Ormsby, Wilton, and Kirkleatham, and enter the German Ocean near or on the SE of Redcar, near the mouth of the Tees : instead of this fault turning westward up the course of the Wharf River, as I conjectured a year ago (p. 80), before having seen the Country, as will be further noticed presently.

By this prodigious eastern *fault*, it has I expect happened, that the magnesian or *Yellow Lime* Rock (with perhaps Coal-measures above it in some places, Report i. 132) occupies the surface *under the Gravel*, *Peat*, &c. on its west side (p. 31) from near Nottingham to somewhere near Pocklington*; but on its eastern or outer side, are *Red Marl* strata,

* And westward thence to near Wetherby, and even to Boroughbridge, probably, since in all the large part of this outer-raised tract, to the west of the line where *Gravel* is seen covering the *Yellow Lime*, viz. from the E of Radford, near Nottingham, by Bobber's Mill, Cinder hill S, Basford NW, Bulwell E, Hucknal-Torkard E, Papplewick W, Annesley Park SE, S, and SW, the Town W, Annesley-Woodhouse W, Kirkby 1 mile E, Sutton 1½ mile E, Mansfield Town E, Mansfield-Woodhouse E, Market-Warsop W, Nether Langwith E, Cresswell E, (in Derbyshire), Belph E, Shireoaks E, (in Notts.) Gateford W, Carlton, Oldcoats W, Harworth W, Tickhill E, (in Yorkshire), Wadworth E, Loversall W, Doncaster W, Arksey E, Owston, Sutton, Hawkhouse, Norton, Walden-Stubbs, Womersley, Gridling-Stabs E, Knottingley E, Birkin, Hillam, Monk-Fryston, South-Milford E, Sherburn E, Barkston E, Towton E, Tadcaster ; and thence perhaps, W of Healaugh, E of Bilton, E of Kirk-Hammerton and Green-Hammerton, S of the

strata, containing accidental beds of *Gypsum*, at Newark and Hawton near it; at Tuxford, and Laxton, Askham and East-Markham near it; at South and North Wheatley; near Thorne, Crowle, &c.; beds of blue *Marl-stone* also occur in it, at Hookerton, Kirklington, Maplebeck, Sutton on Trent, &c. *White Sand* in West Markham, as already mentioned, &c.; and these Red Marl strata, abut against the fault on its E side, to somewhere NW of Howden*; when the Blue *Lias* strata of Long-Bennington, Coddington, and thence E of the Trent to Burton on Strather † succeed, and which strata soon after are lost under Peat and Gravel, and I suppose, abut on the fault, NNW of Howden: after these, other strata higher in the series, range and abut in like manner, under Gravel probably, and then the *Bath Freestone* ranges, along which the Roman Road proceeds from Stamford E of Grantham, Ancaster, Lincoln, Spittal,

the Yore River and of Boroughbridge, and E of Ripon, which is as far N as my information of the eastern edge of the Yellow Lime (covered by Gravel) extends; crossing over therefore E to Sessay, and following the great fault above described, near Easingwold, S of Stillington, S of Sheriff Hutton, S of Crambe; turning then S along the vale of the Derwent to Butter-Crambe, and then SE to join the fault again somewhere W of Pocklington, and thence following the fault already described to Nottingham, all the large intervening space, including almost all the vale of York and Sherwood Forest, has as I am told, an entire surface of Gravel, Peat or other extraneous matters (according to my definition of each, Derbyshire Report i. p. 131), that prevent the regular or undisturbed stratification from being seen; a circumstance which I particularly request assistance upon from your readers, who know or may happen to travel anywhere within this tract, and particularly that they would state, what the two remarkable Hills W of Selby, called Hambleton Hough and Brayton Barfe are composed of? since they can hardly be formed of alluvia?

* In the north-east angle of the great fault, a piece of these same measures seems to remain on the surface, and produces a hall-plaster or Gypsum Quarry near to the Derwent, SW of Westow: and which *Gypsum and Red Marl* are probably in their proper relative situation to the *Lias* † strata, that might be found in Leppington and Bugthorpe (also within the angle of the fault), as I judge, from the Pentacrinus or five-rayed Encrinus there found), (as mentioned Philosophical Transactions, No. 112) especially if it be true, that this curious animal remain, is found in the British series, *only in Lias strata?*; on which question I particularly wish the assistance of your readers; for if they have also a place much higher in the series, it may otherwise explain this part, and the appearance also of these fossils in the banks of the Swale at Topcliffe (and perhaps at Allerton-Maulleverer?) which has induced Mr. Smith to conclude, that the Lias strata are there to be found? and as upper-measures to the Red Marl and Gypsum, said to be found near Thirsk?: and as all the suppositions that can be made on so new a subject of investigation, ought to have a candid examination, are there any local beds of Red Marl and Gypsum, much higher in the British series than the Bath Freestone? that might account for the Gypsum near Westow, and perhaps at Bilton, Green Hammerton and 8 miles E of Knaresborough, in the banks of the Nidd near those places; W of Thirsk, and in Lazenby near the mouth of the Tees, &c. instead of the explanation that I intend to offer herein, regarding all but the first and last of the above-mentioned occurrences of Gypsum?

Wintringham,

Wintringham, and there it disappears under the waters of the Humber, and afterwards under the Peat and Gravel (as I understand) but proceeds beneath these until they abut against the great eastern fault, somewhere SW of Pocklington, and are no where afterwards seen northward in Great Britain, I believe*? The Sand, Limestone and gray Slate of *Colly-Weston*, the *Barnack Rag-stone* and Clay, the *Bedford Limestone* and Clay, and the great *Clunch Clay*, (Derby Report i. 113), the *Woburn Sands* and Clays, &c. above it, and the *Aylesbury* or upper *Oalite Limestone*, all in like manner range successively to the Eastward, and are I believe, cut off obliquely and abut on this fault (perhaps under Gravel and Peat) W and NW of Pocklington: the *Chalk-marl* being perhaps the only stratum beneath the Chalk, that preserves its connection past the corner of the outer or easternmost raised tract of strata (p. 29 of your last number), and after basseting at Birdsal (under *Totternhoe Stone*), occupies the space between the Chalk, east and south of it, near Settrington, Thorpe-Basset, Wintringham, West Heselton, Sherburn, Potter's Brompton, Ganton, Folkton, Hunmanby, and the S end of Filey Bay: and the *Oalite* which it overlies on the west and north &c. sides, near Langton, North-Grimstone, Settrington, Norton, Old Malton, Amotherby, Barton, Stonegrave-Ness, Nunnington, Haram, Nawton, Webburn, Sinnington, Wrelton, Aislaby, Pickering, Thornton, Wilton, Ebberston, Snainton, Brompton S, West-Ayton S, Scamer, Cayton, Lebberton, and Filey S.

Two circumstances seem to conspire, to prevent the tracing of the Malton or upper *Oalite Limestone* far south of that town, viz. the low and flat alluvial surface of the country and the corner of the large lifted and denudated tract that I have mentioned above, and I am not acquainted with any place where this Rock is conspicuously displayed S of this, in Yorkshire, or in Lincolnshire, as mentioned above: north of the corner of this lifted tract, this Rock forms quite a feature of the country, forming the surface in a large tract of very high and at present barren and heathy moors, principally, that stretch out to within seven miles of Northallerton; which extraordinary stretch of strata near the top of the British series, so far to the west, seems occasioned by a trough, or natural depression of the strata rather, perhaps, than to tilts by faults, which may be traced from the vale

* Does Scotland produce any strata of ova-formed Limestone?

vale of the Hull River near Great Driffield, NW, near to West-Lutton, Wintringham, Kirby-Misperton, Helmsley, Old-Byland, and Over-Stilton, to the great fault perhaps, somewhere N of Northallerton; and which occasions the *London Clay* series to advance beyond Kendall, the *Chalk* beyond Wintringham on each side, the *Chalk-marl* almost to Helmsley, the *Aylesbury Limestone* to Keebeck, and the under strata of Coal-measures and Alum-shale near to Osmotherley at least; the *dip* being obliquely towards this line, itself declining eastward, but unequally in different parts; a low part of this trough, seeming to occasion the running of the Derwent W from near Filey to meet other streams coming eastward, on the N of Malton.

The upper edge of this Limestone stratum has been mentioned, in speaking of the Chalk Marl; its lower edge and line of its extent on the surface may be traced, near Westow Crambe, Bulmer, Terrington, Dalby, Bransby N, Owston, Coxwold E, (with detached hummocks at the Towns of Crake and Coxwold); then turning NE and E, owing to the deep and large excavation of the Rye River and some of its south branches (which has exposed the Coal-measures on Grimstone-moor E of Yearesley) N of Newboro' Park, NE of Yearesley, SE of Shackleton, by Hovingham, crossing the Rye NE of this, by Stonegrave, S of Oswaldkirk (having inclosed a Limestone cap or hummock at Colton, and NW of it), Ampleforth, Oldstead, Kilburn S, Sutton under Whitsuncliff E, Thirlby, Boltby, Kirby-Knowle NE, (the town standing on a detached hummock), Cowsby, (Keebeck standing on a detached hummock), Arden-Hall N, Hawnby SW, S, and SE, Carleton 1½ mile N, Skiplam N, Gillamoor N, Hutton in the hole S, Lestingham S, Cropton SW, S, and SE, Newton N, Saltersgate or Half-way house S and SE, Lilla-cross S, Braxey W, Everly SW and S, (with a detached hummock E), Falsgrave S, Oliver's Mount ?, Wheatcroft W, Osgodby, and Gristhorpe N, where it shows its under strata on the shore of the German Ocean: such are the results of my observations and inquiries, respecting the Locality of this interesting Oalite Rock, on which I shall be thankful to receive any corrections or additional particulars, from the kindness of your Readers, particularly such as can enumerate the extraneous fossils found in particular spots.

From near Gristhorpe and Filey above mentioned, the measures that succeed these, below in the series, (with several local peculiarities of dip, that I must reserve for another

other opportunity) occupy the coast in succession to near Marsk, and where the great eastern fault that has been mentioned above, seems at once to cut off and conceal from the sight, all the strata (that have been mentioned p. 96 and 97 above), between these and the Red Marl with Gypsum beds, of which there are said to be large quantities near to the Tees, N of Lazenby in Kirkleatham: whether these Red Marl strata occupy all the north-west side of the great fault that I have supposed and mentioned, turn its W corner and proceed on the W side of Thirsk, where I have been told that Gypsum is dug, as before hinted, I am unable to say, any more than whether, the magnesian Limestone, that is described in Mr. John Bailey's excellent Report on Durham County, as overlying the great Newcastle Coal-series from near Sunderland to near Piersbridge on the Tees, is an immediate under-measure to the Red Marl, that I have been speaking of? and whether it be the same with the Nottingham, Derby and Yorkshire magnesian or Yellow-lime Rock? and whether these actually connect, by way of Knaresborough, Ripon, Bedale, E of Richmond, &c. as I have been told by some is the case? are questions on which I am exceedingly desirous of accurate information; and would take the present opportunity of mentioning, that the lower or calcareous part of the Newcastle series, as described by Mr. Bailey, and by Mr. Westgarth Forster (see his "Section of the Strata") seem, in the blending of Gritstone, Shale, Coal-seams, &c. with the Limestones producing Mineral Veins, to differ so essentially from the lower, or indeed any part, of the Derbyshire series, as to be with the utmost difficulty referred to the same part of the general-series, as hinted in the note, p. 80, of your last number.

Whether, in case of the identity of the magnesian Lime Rocks and their under Coal-measures in Derby and Durham being established, the great fault that enters the island near Hartley in Northumberland (see the Map affixed to the "Picture of Newcastle,") by turning more southward, after re-entering that County N. of Ebchester, may range across Durham and the North Riding of Yorkshire, to connect perhaps with the great zigzag fault of my Derbyshire Report and p. 32 of your last number, (on which I have more to say herein), and thereby entirely cut off and disconnect the upper and lower parts of what Mr. Forster has joined together as *one series*, perhaps about the 244th fathom of his Section, being the place where Mr. W. Miller's-engraved

 Section

Section begins (and proceeds downwards further even than Mr. Forster's), and by this means, make the *Coal* and the *Lead* districts of Northumberland, Durham, and Yorkshire to have no immediate or known relation to each other in the series, I am unable to say at present: but certainly this is one of several suppositions that ought to be fully tried, by an actual survey, before admitting the identity of such very different series of strata as compose the Lead districts of Derbyshire, and the Counties above mentioned.

But I return to the measures in Yorkshire, E of the great eastern Fault, that basset from under the Oalite Limestone, and occupy a space more or less wide on the SW and N sides of that limestone tract, from near Westow on the SSW of Malton, by Spittal-bridge, Sheriff-Hutton, Coxwold, Thirsk, Northallerton, Stokesley, Gisborough, Marsk, Danby, Lyth, Whitby, Goadland, Cloughton, Scarborough, &c. &c. and have to mention that I find these, after a careful examination of the Country about Lyth (on which I intend to say more at a future opportunity) to be *Coal-measures*, and consider them not less remarkable as occurring in a much *higher part of the British series*, than had hitherto been supposed to contain any *vegetal impressions* or other true indications of Coal*, than as containing numerous

* Candour and truth require, that I should here recall some too confident and hasty expressions, on what I had been led to think a true position, viz. that no distinct small *vegetal impressions* like those of the Coal-measures, were to be found in the British Series above the Lias and Red Marl, as I have said in the article *Coal*, and some others in Dr. Rees's Cyclopædia, and in Dr. Dickson's Agricultural Magazine, vol. i. p. 116, and vol. ii. p. 30, the latter in answer to a defender of the disastrous scheme of sinking for Coals at Bexhill in Sussex; and it is somewhat singular, that the call or challenge which I therein gave (p. 31) to produce a single specimen of such impressions found at Bexhill, or in any upper part of the series of strata, has not had the effect of obtaining either public or private information of such an instance, until I saw the strata in the north of Yorkshire, above alluded to in July last. I now however think it highly probable, that the strata around Battel, and eastward of it in Sussex, belong to these Coal-measures (though I saw no vegetal impressions there) and that the appearances of thin seam of Coal seen N of Court-lodge in Mountfield, E of Mountfield, at Darvel-furnace near Robertsbridge, Silver-hill near Salehurst, &c. which I heard of in 1806, but referred to imperfect accounts of *Wood-Coal* or bituminated Wood in the Pipe Clay stratum (below the Chalk, and not above it, as I now understand the Clay of Purbeck to be): but without much altering my opinion of the improbability of discovering even one *useful seam of Coal* at Bexhill, or in any other part of Sussex. I further think, that the appearances of Coals that have been mentioned at Brill N of Thame, Southcote near Leighton Buzzard, in Stone-lane, between Leighton and Woburn in Bedfordshire, near Bolingbroke in Lincolnshire, and in numerous other places, in the range of the *Clunch Clay*, are to be referred to these Coal-measures, instead of Bituminated Wood or Clay, as Mr. Smith and myself used to think; a conjecture of which coincidence of the Clunch-Clay and the Alum Shale, I offered at p. 259, of your 35th volume.

merous

merous species and vast numbers of *animal remains mixed with its vegetal remains*, and as containing *but one seam of Coals*, and that a thin one, rarely amounting to 9 inches thick, and never exceeding 18 inches, as I believe, after a pretty extensive inquiry: though there is often a partial layer of wood-coal a good deal below it.

The account of Mr. Edward Martin's South-Wales Mineral-basin has, I observe, been by a mistake in the note in the Philosophical Transactions, and p. 28 of your last number, referred to the volume for 1808 instead of 1806.

From all that I had read or heard, respecting the northern termination of the valuable Coal-field of the West Riding of Yorkshire, some distance N of Bradford, Leeds, &c. and hearing how much wider this field was W and NE (from Halifax to Fryston-Hall near Ferrybridge) at no great distance before its termination, than it is anywhere S of this in Derbyshire: I rather too hastily (as it now appears) concluded, that the zigzag fault (Derby Report i. p. 168, and p. 32 of your last number) was diminishing northward in Yorkshire, or the rise becoming less on its W side, and that it would soon terminate, so as to admit a complete and more extensive series of Coal-measures basseting, in regular succession, about the parallels of Leeds and Wakefield than I had seen, as hinted p. 176 of my Report: and that in consequence there must have been a *fault*, unconnected with this zigzag fault, that ranged E and W about the course of the Wharf River, &c. (p. 30 of your last number), against which the several Grit-stone Rocks and Coal-shales abutted, nearly at right angles: on examining the country about Wakefield and Leeds and NE of it last August, I find however these facts to be very materially different, and that the zigzag fault continues northward of Dinnington (where it is shown in the Map in your last number) to increase and act a still more important part in the structure of the country, than it has done south of this; its route probably being, near to Hooton-Roberts, Clayton, Featherstone, Castleford, Church-Garforth, Barwick in Elmet, Thorner, Bardsea W, East-Keswick W, Sicklinghall, &c.; and perhaps, if the Yellow Lime continues much further northward? it may continue to follow its western edge until almost arrived at the Tees, and then diverge from it westward to let out the Newcastle Coal-field, as has been already hinted, page 99.

Those three remarkable and characteristic strata, taken in connection, the coarse 3d Grit Rock of Freestone, the

 thick

thick 3d Coal-shale upon it, containing Crowstone, Ganister or Galliard, and the 4th Rock on this, of excellent gray Slate and paving-stone, were left off in my Survey for the Derbyshire Report, at Penistone (Yorks.), and a little NW of it, ranging then almost NW, and proceeding, as I rightly conjectured, for Huddersfield and Ealand on the Calder (Report i. 164), and from the recollection that I had of the range of the strata at Halifax, since I was at school there with the late Mr. Robert Pullman in 1783, I was not a little surprised, on visiting Woodhouse and Headingly NW of Leeds, in company with my very valuable Friend (acquired entirely through a correspondence on these subjects in your Magazine) Mr. Smithson, in August last, to observe there these three strata with all their usual characteristics and some others, ranging about ENE and dipping southward, making direct for the edge of the Yellow Lime, and against which and the zigzag fault, I satisfied myself by numerous inquiries, that they actually abut near Thorner, the 4th Rock being there elevated, on the SW of the Town, to the level of the Yellow Lime on its E side ! ; and that all the numerous upper strata to these, had made a like but less extensive turn eastward, and had disappeared or basseted northward, instead of abutting in that direction against a fault, as supposed.

The range of the 4th Rock, as an index to all the rest, may be, from Penistone by May-Thorn, Brake-hole, Almontbury, Huddersfield E, Linley, Ealand, Southowram, Bank-top, Thornton, Allerton, Heaton, Eccleshill in Idle, Stanningley, Bramley village (the famous quarries at the Fall by the Leeds and Liverpool Canal, being in the 3d Rock), Headingly S, Woodhouse N, Chapel-Allerton, Rounday S of Shadwell, and Thorner. The 3d Rock, I believe, abuts on the Yellow Lime and zigzag Fault between Thorner and Bardsea, at a still higher level ! and it seems probable, that this southern dip continues, until the 2d and 1st Grit Rocks and 1st Coal-shale and the Limestone-shale are brought round to abut on the zigzag fault, near to the edge of the Yellow Lime: but still it seems, that a branch from the zigzag fault must range westward, not far beyond the Wharf River perhaps, and near Otley, Keighley, &c. (as mentioned p. 30 of your last number), as otherwise, if the dip continued, the Mineral Limestones and alternating Toadstones of the Derbyshire series must basset, N of Otley or W of Ripley, of which I never heard the probability ; but the Limestones and other strata there seem, as far as I have heard, to answer nearly to the lower part of Mr. Westgarth

Forster's

Forster's series, as already hinted p. 100: unless indeed, they can be referred to anomalous beds in the Limestone Shale? like other remarkable ones that are mentioned in the Derby Report i. p. 228, &c.

In the preface to my Derbyshire Report p. xiv. I have mentioned the Red Marl strata containing Gypsum beds, that had been said to cover or lie on the top of the Yellow Lime Rock at Fairburn N of Pontefract in Yorkshire, and the importance of ascertaining (as I have no where yet been able to do) *What is the regular or proper covering stratum to this Lime Rock?* made it among the most interesting objects of my visit to Mr. Smithson, to go with him and view these Gypsum quarries; but before I mention my observations at Fairburn, it will be proper here to give a more exact account of the Western edge of the lower part of the Yellow Lime Rock (where it is seen covering the Coal-measures) to the north of the Anstons in Yorkshire, than is to be found at page 156 of my Report, and which, from what I have seen and been informed, is as follows, viz. North-Auston, Dinnington SW, Laughton-en-le-Morthen W, Slade-Hooton, High-Hooton, Maltby S, E, and N, Clifton W, Conisborough SE and E, Cadeby S and W, Melton SW, Barnborough NE, Hickleton, Hutton-Pagnell, Moorhouse E, Stubs-Hall, North-Elmsall W, Upton NW, Went-Bridge, (very probably with some detached hummocks to the W) East-Hardwick, Darrington W, Pontefract E, Glass-Houghton E, Fryston-Hall S, Ferrybridge W, Brotherton SW, Fairburn SW, Newton-Abberth S, Kippax SW, (with two curious detached hummocks SW) West-Garforth, Moor-Garforth, Barwick in Elmet E and NE, Potterton SW, Kid-hall, Thorner Church, East-Rigton W and N, (with a small and a large hummock north of this between East-Keswick and Collingham), Compton NW, (where my maternal Grandfather lived), Wattlesike, Linton S, Wood-hall N, Sicklinghall E, Spofforth E and NE, Plumpton Hall SW, High-Harrowgate NE, Knaresborough W, &c.*

After ascending with Mr. S. the edge of the Limestone at Newton-Abberth, in our way to Fairburn, I was soon after

* In the Rev. William Atkinson's collection at Boston, near Thorp-Arch, I saw some turbinated and scallop shells in dark-gray Limestone from Allerton-Mauleverer, that may perhaps belong to the blue beds in the lower part of the lower Yellow Lime Rock (unless they belong to the Lias as before hinted) Report i. 157; and the Coals which G. B. Greenough, Esq. observed working at Arkendale NW of this, last summer, may be those called the Bilborough Coal, Report i. 166, and those of Parlington near Abberford, and several other intermediate places,

conducted to the north of the Road, and of Fairburn old Limestone Quarries, and in the midst of a common-field, the general surface of which is Limestone with many shallow quarries in it made by the Farmers; we ascended a detached hummock of perhaps four or five acres extent and 40 or 50 feet high, in the SE side of which the Gypsum is dug, in a great number of thin regular beds in red marl, nowise materially different from all the Gypsum quarries that I had previously seen in this marl, except perhaps that the beds of Gypsum are more numerous and thinner than usual: standing on the top of this interesting hummock (which has been dug over for Gypsum) with Mr. S. I remarked to him, that here were certainly undisturbed strata upon the Limestone Rock that we had ascended from the Coal-measures, and that the green hills in the inclosures to the north, showed marks of the ancient diggings of Gypsum or Marl in their sides, and doubtless were similarly constructed to that on which we stood: but observing, that the Limestone hill about five or six furlongs to the east of us, on which the village of Fairburn stands and the great North Road passes north of it, was much higher than the Limestone field that surrounded us, or than this hummock, I remarked, that either a fault must range between us and that hill, and had raised that so materially (previous to the denudation that had left these singular hummocks), or, that there were two Limestone Rocks, on the upper of which Fairburn stood, and Newton on the lower, and that these Marl hummocks were the remains of a stratum between these Rocks. We lost no time in reaching Fairburn to verify, if possible, one or other of these suppositions, and soon found on inquiry, that several of the Wells in the village had been sunk through Limestone into similar Marl with Gypsum beds: a more decisive proof however immediately offered itself, in a Tunnel that Mr. George Althas had about two years before driven under the Village and Turnpike Road, at 54 feet deep, for conducting a rail-way branch from the Air Navigation, into the deep Limestone quarries N of the Road, which Tunnel passed along this Marl and Gypsum stratum: in examining of which in its place at bottom of the quarry, I was then and since able to detect several errors that I had fallen into when on my Derbyshire Survey, and examined patches of loamy Sand and marly substances on the planes of Yellow Lime, in different places, and which, from having seen or heard no instance of such basseting, or having a regular place between the Limestone Rocks, and owing chiefly to the vicinity or admixture of the Sherwood-

Forest

Forest Gravel near or in the top of such patches, I concluded all such to be, and have described them as *alluvia*, and have in consequence, omitted to observe or notice, a most important feature of the *Yellow Limestone* Rock, or Rocks rather, that of their having strata of Red Marl (sometimes holding Gypsum and other substances), ochry clay, loamy or founders' sand, &c. interposed between them, of very variable appearance and thickness, but sometimes capable of forming a feature in the Country, as we have seen to the NW of Fairburn in Yorkshire. I will therefore here mention the places in order, beginning S, near which I suppose that the upper Yellow Lime Rock ends, and these anomalous beds basset, with remarks, as I go along, of the probable errors in my Derbyshire Report, in considering them as alluvia, &c.

I am doubtful whether the Forest Gravel admits of seeing the upper Yellow Lime Rock, anywhere south of Mansfield in Nottinghamshire, (and probably the Red Clay on the Limestone at the south end of that town, of which bricks are made, may belong to these anomalous Beds? and so may the lower and regular part of the large patch of Founders' or casting Sand, Report i. 464, Brick-earth, &c. extending to the Brick-kilns SE of Skegby, Report i. 452, that I have considered as *alluvia* in my Report, owing to the quartz pebbles scattered on its surface), but it probably appears at Mansfield-woodhouse, Warksop Park in Derbyshire, Shirebrook, Over-Langwith, Langwith Lane, Walley-Wood, (west of this, about 1¼ mile E of Bolsover, a hummock of Founders' Sand and red Brick-earth occurs, W of the Turnpike Road, Derb. Rep. i. 135, 463 and 452), Walley village, Bonbuck E (Notts.), Crag-Mill, (west of these, Founders' Sand at Frithwood-Farm, and on Elmton Common, Report i. 464 and 137), Whitwell E, (Redhill, of loamy sand with quartz on it, Report i. 142), Steetley, Shireoaks Park in Notts. Wood-mill, Yorkshire, (Sand and Brick-earth in Thorpe-Salvin, by the Chesterfield Canal, Report i. 141 and 452), Gilding Wells, Letwell, Roch-Abbey E, Braithwell (the Fullers' Earth at Raddle-Pits, Report i. 465, probably belongs to the anomalous beds of the Marl), Edlington, Brodworth E, (Sand and Loam near Redhouse on the York Road, and Founders' Sand near Hutton-Pagnell), Wentbridge W, (reddish Clay in the north Hill, in the York Road), Greave-Park SW, (Clay on a remarkable small Common by the York Road, SE of Pontefract, called the Devil's Bowling-Green), Knottingly E, (here I am informed, that in cutting a canal near the Air River, Red Marl and Gypsum were

were found; to the W, also, Founders' Sand is got at Glass-Houghton and Wereldon or Weldale), Brotherton, Fairburn (Red Marl and Gypsum SW and W, as above mentioned), Ledston E, Micklefield, Abberford, Potterton E, (here and at Whinclose one mile N, near Bramley Park, a white Clay is found, with Galliard or Crowstone-like beds in it, and a white tender Grit-stone or Sand at Bramley-moor Quarry, and at the SE corner of Bramley-Park; a patch of Clay on the Limestone SE of East-Rigton, belong also I expect to the anomalous beds between these Rocks), Bramham 1½ mile E, (a very heavy and curious sparry bed about two feet thick, on the Limestone under Mr. Joseph Bovill's Farm, at the NE end of Bramham Town, belongs perhaps to the anomalies of these Marl beds), Toulson (on the banks of the Wharf River about a mile below Thorpe-Arch, beds of Red Marl and some Gypsum layers appear, and this Marl seems to make a red clay surface on the Lime, N of Thorp-Arch), Bilton (here Gypsum is found, see Mr. James Sowerby's British Mineralogy, Tab. 234), Tockwith, Kirk-Hammerton, Green-Hammerton (at the latter place Gypsum is dug, as I am informed, and between them the Gypsum and Sulphate of Strontian is found, I believe, and in this stratum, that Mr. James Sowerby has figured and described in the last number of his "British Mineralogy," Tab. 444, though said by its discoverer to be had from the banks of the Nidd *near* Knaresborough, which is 8 miles off.

A more particular survey of the western side of the Yellow Lime district, would I doubt not, discover many other curious and anomalous substances, that might be referred to the beds between the upper and lower Rocks of that series. The establishing of local *Geological Societies*, such as I have recommended p. 217, and others of my Derbyshire Report, would prove of the most essential service in promoting and methodising the several inquiries which I have herein suggested, and many others not less important, that will occur to all those who apply seriously to the investigation of the facts of the Terrestrial Stratification, a pursuit in which utility will be found eminently united with the highest species of gratification.

I am, sir,

Your obliged and very humble servant,

JOHN FAREY Sen.
Mineral Surveyor.

Upper Crown Street, Westminster,
February 9, 1812.

XVI. *De-*

XVI. *Desultory Observations concerning certain vegetable Muscicapæ. By Professor* Barton, *of Philadelphia. Communicated by the Author.*

A few years ago, I accidentally discovered that the flowers of the *Asclepias syriaca* of Linnæus*, like the flowers of the *Apocynum androsæmifolium*, are endowed with the faculty of catching and retaining flies and various other kinds of insects. I have given some account of this discovery in the Transactions of the American Philosophical Society †.

In the course of the present year (1811) I have ascertained that the beautiful *Asclepias curassavica* is also a *Muscipula*, or rather a *Muscicapa*. My observations were made on a small and by no means vigorous plant of this species, which I had raised from seed. These observations convince me that this *Asclepias*, in its native climate, or any where else when adult and vigorous, must be a powerful and even *useful* fly-catcher. It often so completely retains insects, even pretty large house-flies, that they are wholly incapable of disengaging themselves, but perish upon the flowers. Others, hardly more fortunate, escape with the loss of their proboscis, or some of their limbs. Few, perhaps, escape *entirely* uninjured.—The mechanism by which *Asclepias curassavica* catches flies, is nearly the same as that by which they are caught in *Asclepias syriaca β*.

As the genus *Asclepias* consists of a considerable number of species, and as all the species are so similarly constructed that there is no good reason to doubt that they are all endued with the power of catching insects, it is easy to perceive what an immense havoc these plants must make of *animal* life, especially in many parts of the United States, where some of the species of *Asclepias* are so numerous that they cover hundreds of acres of ground, in close connexion, especially along the banks of our rivers, in the sandy fields, &c.

In the short paper entitled “ Memorandum concerning a new Vegetable Muscipula,” which is inserted in the Transactions of the American Philosophical Society, and to which

* *Asclepias syriaca β.* of Michaux.

† Vol. vi. part i. No. xvi. p. 79—82. Mr. Sonnini has given the credit of this little discovery to an English naturalist of my name. The respectable French naturalist, speaking of the *Asclepias syriaca*, says, “ Une propriété curieuse de ces mêmes fleurs, dont la découverte récente est due au Docteur Barton, de *Londres*, c'est qu'elles attrapent les mouches qui s'y posent attirées par le suc mielleux qu'elles contiennent.” —“ Plus de soixante mouches furent prises . . . . . sous les yeux de l' observateur *Anglais*, &c.”—*Journal de Physique*, &c. tom. lxvi. p. 219.

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I have already referred, I have, I fear, fallen into an error concerning the *Nerium Oleander*, or common Rosebay. My words are these: "It has long been known that this is a poisonous plant. But I do not know that any person than myself has observed that this fine vegetable proves very destructive to the common house-flies. These insects visit the *Oleander*, in order to drink the fluid secreted in the tube of its flowers. The liquor soon intoxicates them, and very few of those which have gained admittance into the blossom ever return from it. So great is the number of flies destroyed in the course of one season by a single *Oleander*, that I have often thought it would be worth our while to pay more attention, than we yet do, to the cultivation of this vegetable; as, independently of its beauty, it is so well calculated to lessen the numbers of a most common and troublesome insect."

Subsequent and more cautious inquiries have convinced me, that although the nectareous fluid of the *Oleander* may prove deleterious to flies, yet that the greater number of the insects which are observed dead or dying, in the flowers of this plant, have been entrapped by the irritability of the *genitalia*; by a mechanism, at least, as truly irritable as that by which insects are detained in the flowers of the different species of *Asclepias*, of *Apocynum*, and other similar plants.

In the course of my inquiries and labours concerning the indigenous plants of the United States, I have had the additional satisfaction of remarking, that one of our Grasses is also a *Muscicapa*, or at least a catcher of small insects of various kinds. And, so far as I know, it is the only grass, hitherto discovered, that is entitled to the name of a *Muscicapa*.

The grass to which I allude is the *Leersia lenticularis* of the late Mr. A. Michaux*. This plant is a native of the marshy grounds of the Illinois country, of Virginia, North Carolina, &c. I do not know that it has been found in Pennsylvania. The glume or corolla consists of two valves, a character which belongs to all the species of the genus *Leersia*. In the *Leersia* which is the subject of my observations, the glume is of an orbicular form, inclining to lenticular, and is much larger than in any of the other American species that are known to me, or than it

* Leersia (*lenticularis*) paniculæ ramulis subsolitariis, ramillis secundariis imbricatim spicifloris: glumis lenticulari-orbiculatis, conspicue ciliatis, majusculis.—*Flora Boreali-Americana*, &c tom. i. p. 39.

is

is in the *Leersia oryzoides* of Europe and America. The edges of the valves are very distinctly ciliated, or furnished with a number of fine teeth or delicate spinules.

It is this ciliate structure that enables the plant to perform the business of a *Muscicapa*. When a small insect, such as a spider or a minute fly, insinuates itself between the valves (probably in pursuit of a honeyed fluid), the valves close upon it, the spinules enfolding each other; thus retaining the insect, which, I presume, as seldom escapes as the insect that has been caught by the valvular structure at the ends of the leaves of *Dionæa Muscipula*.

In the *Leersia oryzoides* of Swartz and Michaux (*Leersia virginica* of Willdenow), which is called in the United States "Cut-grass" and "Sickle-grass," the structure of the *glume* is very similar to that which I have just described. In particular we observe the ciliated structure, though it is less conspicuous than it is in the *Leersia lenticularis*. No doubt, the former as well as the latter of these grasses is entitled to the appellation of a *Muscicapa*. But I have not yet observed insects between the valves of the *Leersia virginica*. I may hereafter inquire more particularly into the subject.

In Georgia and in Florida there grows a beautiful shrub to which the inhabitants have given the name of "Fly-catcher." This shrub is the *Befaria paniculata* of Michaux *. The inhabitants collect branches of it, when it is in flower, and hang them up in their rooms, and find the flowers of very great use to them in ridding them of flies: hence its name, which I have mentioned, and the only one, so far as I can learn, by which it is recognised in its native country.

I am not sufficiently acquainted with this plant to say, with certainty, by what power it is that it catches, entangles, or destroys the flies; whether by a contractile or irritable property, residing in some of the parts or organs of the flowers; whether by the glutinous quality which belongs to the flowers; or whether by a deleterious quality belonging to the nectar of the flower. I may, however, observe in this place, that the *Befaria* is one of the vegetables from which the bees in the countries of Florida, &c. are thought to procure a narcotic or deleterious honey. Still I suspect that the muscipulating faculty of this plant will be found to be owing to a peculiar mechanism; that

* Befaria (*paniculata*) ramis hispidissimis: foliis ovali-lanceolatis, glabris; panicula subaphylla, multiflora, glutinosa.—*Flora*, &c. tom. i. p. 280. tab. 26.

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is, to an irritable power residing in the flowers. But this point remains to be determined by better observations. I have never yet had an opportunity of examining the *Befaria* in a *living* state.

I might here give a long list of vegetables, such as different species of *Rhododendron, Kalmia, Robinia, Silene, Lythrum*, which by virtue of the viscosity upon different parts of their flowers, &c. entangle and destroy small insects. But my business in this imperfect essay is not with *Muscicapæ* of this kind. Yet a more critical inquiry into the use of this viscous matter, in the vegetable œconomy, by which millions of insects are destroyed in our gardens, green-houses, woods, &c. might deserve the attention of physiologists.

In regard to the *Sarraceniæ*, as I design to make their history, *botanical, physiological* and *medical*, the subject of a distinct memoir, I shall content myself at present by offering a few detached facts and observations concerning these plants.

It is well known that all the species of this singular genus (and I think at least seven species have been discovered in North America) are inhabitants of the water, or of wet situations. All the species are furnished with tubular or hollow leaves (*ascidia*), which in the more *adult* plants are seldom found without a considerable number of insects dead or living in them. I do not mean, however, to insinuate that these insects owe their presence in the *Sarraceniæ* to any thing like an *irritable* property residing in any part of the plants. Indeed, I have not discovered any vestige of peculiar irritability in the constitution of the *Sarraceniæ*. But I think it sufficiently evident that nature has taken some pains (if it be ever allowable to use such language in speaking of the works and operations of Nature) to solicit insects into the ascidia of the species of this genus.

Thus, the flowers of the *Sarracenia flava* (the yellow Trumpet-leaf or Side-saddle-flower of the people of the United States) have a most offensive, cadaverous or carrion-like odour. This odour, to speak more properly, seems to reside principally, if not entirely, in the broad peltated stigma of the plant. I think it probable that it is, *in part at least*, this odour, which is so potent and diffusible that it is sometimes perceived at a considerable distance from the plant, in a warm and rather confined atmosphere; that it is partly this odour, which serves to solicit various kinds of insects about the plant, many of which before they can reach

reach the stigma are necessarily entrapped in the ascidia. But I know not what may be the final intention of Nature in giving the peculiar odour which I have mentioned, to the stigma of *Sarracenia flava* and some other species of the genus. Those philosophers* who imagine that there are some plants which cannot be impregnated without the aid of insects, may perhaps fancy that they have discovered Nature's ulterior object in the present instance. Indeed, I confess myself at a loss to conceive how, in some of the species of *Sarracenia*, the pollen or fecundating influence of the stamens can reach the *upper* surface of the stigma. See in my Elements of Botany, and in other works, the figure of *Sarracenia purpurea*.—And I presume, that it is certainly upon the upper surface of the stigma of these plants that the pollen, or at least its *fovilla*, must be applied, in order to enlarge and render fertile the embrya seeds. In the *Sarraceniæ*, the aid of insects in giving fertility to the germen or ovarium may *possibly* be necessary. I think it cannot be much less necessary (if at all less necessary) in *Sarracenia purpurea*, than it is said by Mr. Willdenow, Dr. J. E. Smith, and other respectable botanists, to be in *Aristolochia Clematitis*.—See Willdenow's Principles of Botany and of Vegetable Physiology, English translation, pages 316—318. Edinburgh, 1805†. But although I believe in the doctrine of the sexes of plants as a *general* doctrine, I am compelled by many facts and considerations to doubt whether the impregnation of *any* vegetable is *necessarily* dependent upon insectile aid‡. On this curious subject I shall offer something more specific in my "Memoirs on the Origin and Progress of our Knowledge concerning the Sexes of Vegetables."

But there is still a much more considerable and obvious

* Linnæus, Sprengel, Willdenow, Smith.

† See also Dr. Smith's Introduction to Botany, &c. page 337, &c. London 1807. This botanist not only reposes confidence in Willdenow's theory of the insectile impregnation of *Aristolochia Clematitis*, but he thinks it probable that "for want of some insect adapted to the same purpose in its own country, the American *Aristolochia Sipho*, though it flowers plentifully, never forms fruit" in the British gardens. However it may be in *Aristolochia Clematitis*, I am persuaded that insects are not necessary agents in the impregnation of the germ of *Aristolochia Sipho*, or "Dutchman's-Pipe," as it is called in Pennsylvania. I am well acquainted with this plant, and cannot perceive from the structure and disposition of its genitalia any obstacle to the application of the pollen to the female organ. Certainly, there is much less difficulty in conceiving how impregnation is effected in this *Aristolochia*, than in hundreds of other plants, concerning the impregnation of which no difficulties have ever occurred in the minds of botanists.

‡ "The dichogamic plants can be in no other way fecundated than by insects."—*Willdenow.*

cause of the collections of insects which are so frequently observed in the ascidia of the *Sarraceniæ*. These ascidia, in some if not in all the species of the genus, appear to possess a kind of glandular function, like the true nectaries of a great many plants. A honeyed fluid is secreted or deposited on the inner surface of the hollow leaves near their *faux* or opening; and it is this fluid which allures great numbers of the insects, which they are found to contain, into the ascidia.

I was entirely unacquainted with this curious œconomy in the ascidia of the *Sarraceniæ* when I published the first edition of my Elements of Botany; and even when I printed the Appendix (in vol. i.) to the second edition of this work. The fact will not be deemed uninteresting by the cultivators of vegetable physiology, since it somewhat enlarges our views of the uses of the ascidia, and may assist us in making a better disposition of these parts among the glands, or glandular-like organs, of vegetables. I have little doubt, moreover, that a more accurate examination of the genera of *Nepenthes*, *Aquarium*, and similar plants, of which the number is not inconsiderable, will render it certain that a honeyed fluid deposited about the opening of the ascidia of these remarkable plants, is in them, as in the *Sarraceniæ*, the *principal* cause of the deposits of insects which the tubular leaves are so generally found to contain. Let me add, that in the American plants, of which I have been speaking, the honeyed fluid may often be very distinctly seen; though sometimes, especially in the warmer weather, it is only to be discovered by the *taste*.

Many insects, as well as some other animals, are found in the ascidia of the *Sarraceniæ*, *Nepenthes*, &c. which do not appear to have been solicited thither either by the cadaverous odour of the flowers, or by the honeyed fluid about the opening of the tubular structure. In the *Sarraceniæ* we find species and sometimes large species of *gryllus*, or grasshoppers, of *gyrinus*, &c. And Rumphius, speaking of *Nepenthes distillatoria*, informs us that "various little worms and insects crawl into the orifice and die in the tube, except a certain small *squilla* or shrimp, with a protuberant back, sometimes met with, which lives there." Smith's Introduction, &c. pages 197, 198. Dr. Smith has "no doubt, that this shrimp feeds on the other insects and worms, and that the same purposes are answered in this instance as in the *Sarraceniæ*."

It is certain, that a remarkable instinct directs some species of insects to visit the ascidia of different species of *Sarracenia*,

Sarracenia, principally, if not entirely, for the purpose of depositing their eggs or larvæ in them. We often see some of the larger species of *Musca* and *Tabanus* sitting upon the edges of the openings of the ascidia of *Sarracenia flava* and *Sarracenia purpurea*. We soon find that they do not come here, as do the majority of insects, for the purpose of sipping the honeyed fluid from the ascidial glands. The mother-insect, carefully poising herself upon the brim of the ascidium, emits from her uterus into the tube one or more larvæ, which immediately betake themselves to the lower part, where meeting with abundance of good food, they rapidly increase in size and in strength.

I must give to Dr. Smith the credit of having preceded me in making, or at least in recording, an observation nearly allied to the one which I have just detailed. "An insect of the *Sphex* or *Ichneumon* kind," as far as he could learn from the description communicated to him, "in the Botanic Garden at Liverpool," "was seen by one of the gardeners to drag several large flies to the *Sarracenia adunca*, and, with some difficulty forcing them under the lid or cover of its leaf, to deposit them in the tubular part, which was half filled with water. All the leaves, on being examined, were found crammed with dead or drowning flies." "The *Sarracenia purpurea*," adds Dr. Smith, "is usually observed to be stored with putrefying insects, whose scent is perceptible as we pass the plant in a garden." This I have not observed: and perhaps the odour spoken of may be that exhaled from the flowers, or *genitalia*, of the plant. "Probably (the learned English botanist goes on to observe) the air evolved by these dead flies may be beneficial to vegetation, and, as far as the plant is concerned, its curious construction may be designed to entrap them, while the water* is provided to tempt as well as to retain them. The *Sphex* or *Ichneumon*, an insect of prey, stores them up unquestionably for the food of itself or its progeny, probably depositing its eggs in their carcases, as others of the same tribe lay their eggs in various caterpillars, which they sometimes bury afterwards in the ground. Thus a double purpose is answered; nor is it the least curious circumstance of the whole, that an European insect should find out an American plant in a hot-house, in order to fulfil that purpose."

* It is evident, from what has already been said, that it is not the water in, but the honey about and upon, the ascidia, which tempts the greater number of insects to visit these tubes, in the different species of *Sarracenia*. Neither is it the water that retains them.

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I feel much obliged to Dr. Smith for leading me, by the preceding observations, to pay a more critical attention than I might otherwise have done to the œconomy of the *Sarraceniæ* and other ascidial plants. Hitherto, however, I have not observed any species of *Sphex*, or of *Ichneumon*, engaged in the singular business which he has mentioned. And although I do not doubt that the gardener's statement is in the main correct, yet I incline to think that the supposed *Sphex*, or *Ichneumon*, was an insect of some other family. Future observations will, I hope, enable me to determine this point entirely to my satisfaction.

Although I have no doubt that plants may derive much of their nutriment and strength from the elements of decomposed animal bodies, just as I suppose that innumerable species of animals are nourished by inorganic matter; and although it is possible that the air evolved by the dead insects in the ascidia of the *Sarraceniæ* and other similar plants may contribute somewhat to the vegetation of these plants, yet I cannot suppose that the final intention of Nature in furnishing plants with ascidial leaves is to lay up a store of nutritious aliment for the plant.

So far as the species of *Sarracenia* are concerned in this view of the subject, I hardly know any plants to which such storehouses as we are speaking of would be less necessary. For they live in the midst or upon the margin of marshes, where animal matters of various kinds are continually putrefying, and where of course the plants are almost constantly surrounded by an atmosphere of azotic and hydrogen gases.

Again, the wonderful *Dionæa Muscipula*, the extremities of whose leaves entrap, and frequently retain for a considerable time, various small species of insects, resides only in marshy grounds, not much unlike those just mentioned. In this plant, it appears to me to be still more difficult to give a plausible guess about the intention of Nature in constructing these vegetable *Muscicapæ*, than in regard to the *Sarraceniæ*.

If, however, we were acquainted with only the last-mentioned vegetables, with *Nepenthes* and with *Dionæa*, as the only plants, I say, endued with the power, however different the means, of catching or entrapping insects, we might, perhaps, with some degree of reason imagine that this faculty is, somehow or other, subservient to the business of vegetable nutrition. But never can this idea be extended, with even the faintest shadow of a good theory, to those truly irritable *Muscicapæ*, *Apocynum androsæmifolium*,

Asclepias

Asclepias syriaca, *Asclepias curassavica*, *Nerium Oleander*, and many others, whose flowers entrap insects or the *parts* of insects. For, in these plants, the whole quantity of animal matter applied to and retained by the plants, in their most vigorous state, is a mere atom in comparison of the volume of living vegetable matter to be nourished. Moreover, the animal matter is applied only to the flowers, which no one imagines to be essentially concerned in nourishing the plant; to the *temporary* organs, and not to those which may be called permanent, the leaves or ascidia.

In making these observations, I have not an eye to the theories or speculations of any particular author. I must confess, however, that I once imagined that *Dionæa Muscipula* itself does receive a part of its nourishment from the insects which it entraps. And Mr. Roth, if I do not mistake, has endeavoured to show that the species of *Droseræ*, so common in the bogs of Europe, &c. are, in some measure, indebted for their growth and nourishment to the insects which they entangle and retain. I have not seen the arguments by which the respectable botanist just mentioned supports his hypothesis.

I must not take my leave of the *Sarraceniæ* without observing, that the ascidia of some (perhaps all) of the species of the genus furnish us with still another beautiful example of what the ingenious author of "The Studies of Nature" would call the "harmonies" of the vegetable and animal kingdoms. For, omitting, at present, all further speculations about the intention of Nature in giving to the species of this genus ascidial leaves, and a capacity of entrapping great numbers of insects, it is a fact, that these leaves become repositories of the food of various species of birds. It is not uncommon, in the native soils of some of the species of *Sarracenia*, to see great numbers of birds, especially some *Muscicapæ*, or Flycatchers, and other *Passeres*, assembling about these plants, and, by means of their bills, slitting the ascidia in order to get at their favourite food*. This well ascertained

* Linnæus tells us that the hollow leaf of *Sarracenia purpurea* is a reservoir of water for thirsty little birds. "Folium S. purpureæ in Spec. Pl. descriptum, aquam præbet sitientibus aviculis." *Prælectiones in Ordines Naturales Plantarum*, Edit. Giseke, p. 316. Hamburgi 1792. This is doubtless a mistake. The birds supposed to be sipping water from the ascidium of *Sarracenia* were, I suppose, engaged in the very different business of eating the insects which the reservoir contained. None but a bird with a very long bill would be able to take the water from the tube. Is it likely, moreover, that any bird should be driven to the necessity of satisfying its thirst from the reservoir of a plant which always grows in wet places, and frequently in waters of a foot or more in depth? for *Sarracenia purpurea* is sometimes seen growing in our cypress swamps, its roots, like those of a *Lemna* or an *Utricu-*

ascertained fact will not be deemed incurious in a history of the genus *Sarracenia;* nor unimportant in a history of the instincts and intelligence of the great class of birds. We know much less of the structure and œconomy of the different species of the genus *Nepenthes*, and of the only species of the genus *Aquarium* that has yet been discovered, than we do of the structure and œconomy of the species of *Sarracenia*. But it is highly probable, that the ascidia of both *Nepenthes* and *Aquarium** will be found by future botanists and naturalists to serve the same purpose, with respect to birds, as do the *Sarracenia variolaris* and other species of the genus in America.

The large ventricose ascidia of *Sarracenia purpurea* are employed as cups, for holding and conveying water, by the reapers and mowers in some parts of the United States, particularly, I think, in New Jersey, where the plant is called "Water Brash."

After proceeding thus far, it was originally my intention to have offered some speculations of my own concerning the final object of Nature in constructing VEGETABLE MUSCICAPÆ, and especially those which I have ventured to call *irritable Muscicapæ.* But the present essay has already been extended to too great a length. My intended speculations may possibly form the subject of a future communication. In the meanwhile, these "Desultory Observations" may perhaps contribute to the amusement of some of my brother naturalists, both in Europe and in America. If they shall produce this effect, my principal object in laying them before the public, in their present crude and irregular state, will have been accomplished.

BENJAMIN SMITH BARTON, M.D.

Philadelphia, September 3, 1811.

Utricularia, being suspended in the water and totally detached from the earth. If it be true, as is asserted, that the *Trochilus Colubris*. or common Humming-Bird, is sometimes seen about the ascidia of the *Sarraceniæ*, we seem safe in conjecturing, that this beautiful bird visits these tubes for the double purpose of sipping the honeyed fluid and of eating the insects. I have elsewhere shown that insects constitute a part, and perhaps a considerable part, of the food of this *Trochilus*.—See the Philadelphia Medical and Physical Journal, vol. i. part i. art. xxiv.

* I do not know whether this singular plant (*Aquarium sitiens* of Leschenault), belonging to the natural order of *Succulentæ*, has yet been publicly figured or described by any botanist. I have seen a drawing of the plant, which is a native of Australasia, in the possession of Mr. Leschenauit, when I had the pleasure of knowing this intelligent botanist, and of inspecting a part of his rich collection of plants, &c. in Philadelphia, in 1807. The *Aquarium* grows in a moist but firm soil. Its radical leaves are hollowed, and are in shape somewhat like a water-pot. Each pot is about an inch long, and is capable of containing a good deal of water.

XVII. *Case of Injury of the Head.*

To Mr. Tilloch.

Sir, Different Numbers of your Magazine having at times fallen in my way, and seeing that several medical cases were recorded; I thought I would send you the following notes of a case which has lately come under my own observation, that, if you deemed fit, they may be inserted in your widely circulating Magazine.

From your humble servant,

John Burne.

J. T. aged 36, for the last ten months has been a constable. About five months ago he was struck on the forehead by a man he was endeavouring to secure. He felt very little inconvenience from the blow, and went about his employment as usual.

Jan. 3, 1812. He said he was very unwell, with a dull heavy pain in the head, but he complained of nothing else; his appetite was very good; his bowels pretty regular; his eyesight very good, and he could walk about quite well.

℞ Pulveris Rhei.

Terebinthinæ Chiæ āā ʒj. M. Ft. pilulæ xxx, quarum duas bis die sumat.

℞ Emplastrum Picis compositum Neuchâ.

Jan. 7th, he found himself much better; the pain was nearly gone, and he thought he should have no need to apply again. The above treatment continued.

Jan. 17th. I have heard nothing of him since the 7th till this morning, when he sent to request that I would visjt him, for he was confined to his bed, and very dangerously ill. When I visited him (which was about noon), I was informed from his wife that he had continued to get much better till the 16th, when he was suddenly seized with pain in the head, giddiness, trembling; lost his speech, and the use of his right arm. In this state I found him; the light did not affect his eyes; he seemed very dull and stupid; his bowels were confined:

℞ Submuriatis Hydrargyri gr. vj.

Pulveris Rhei gr. x. M. Ft. pulvis statim sumendus ex Theriacâ.

℞ Emplastrum Lyttæ Neuchâ.

Jan. 18th. Bowels have been purged; has passed a very restless night: cannot speak; in other respects the same: his skin hot and dry.

℞ Misturæ

℞ Misturæ Camphoræ ℥vj.
Liquoris Ammoniæ Acetatis ℥ij.
Liquoris Antimonii tartarizati ʒij. M. Fiat mistura, cujus sumat cochlearia duo ampla quartis horis.

Jan. 19th. No better; has passed a very restless night: cannot speak: right arm still insensible, and he has no power to move it.

℞ Submuriatis Hydrargyri gr. j.
Pulveris Antimonialis gr. ij.
Nitratis Potassæ gr. xv. M. Fiat pulvis quartis horis sumendus ex Melle.

℞ Emplastrum Lyttæ largum toto capite.

Jan. 20th. Somewhat better; can speak a few words, but very indistinctly: has had no sleep; the light during the whole time has produced no pain or inconvenience to his eyes: there is much stupor and dulness about him; he complains of nothing, but shakes his head when he is asked how he does. The powders continued.

Jan. 21st. Has had a little sleep; can speak rather more distinct; his right arm is sensible to the touch, and he can move it a very little. The same treatment continued.

Jan. 22d. His bowels are regularly open; has passed a better night; moves his right arm rather more freely, and can take a little food. The powders continued, but not so often.

Jan. 24th. Much better; can sit up in the bed and eat some meat; sleeps tolerably well, but has a troublesome tickling cough. The powders are discontinued.

℞ Oxymellis Scillæ.
Syrupi Papaveris albi āā ℥j. M. Cochleare minimum urgenti tusse capiat.

Jan. 30th. Cough relieved: has taken no other medicine; he is able to get up and walk about the room: appetite pretty good; his right arm is more sensible, and he can move it much better; speaks more distinctly. I put a seton in the back part of the neck, and ordered him to take no medicine whatever.

Feb. 12. The seton has discharged copiously, and he has found very great benefit from it; he sits up all day; can walk very well; has quite recovered the use of his arm: appetite very good; sleeps very well, and can speak nearly as well as ever, and now wants nothing but strength to enable him to resume his former employment.

Is it not most probable that the above symptoms were occasioned by effusion causing compression in consequence of the blow, or by inflammation? The symptoms seemed to indicate the former more than the latter.

Hatton Garden, Feb. 17, 1812.

XVIII. *Com-*

XVIII. *Communications from Mr.* Allan *and Mr.* Stancliffe *on Allan's Dividing Instrument.*

To Mr. Tilloch.

Sir, I beg leave to inform you, that Mr. Stancliffe wrote his first opinion of my improvement on the mathematical Dividing Engine, after he went home from seeing the wooden model at the Society's house, *and before he saw the engine itself*. As I was surprised to see such an opinion inserted in the Society's Transactions, after giving his approbation in so strong terms when before the Gentlemen of the Committee of Mechanics appointed by the Society of Arts to view the engine at my house on the 15th of December 1810, I mentioned the circumstance to him, and told him of some observations in a certain obscure publication; in consequence of which he has thought proper to favour me with the enclosed paper.

Mr. Stancliffe has for many years been justly celebrated for his extraordinary nicety in dividing, as well as for his extensive knowledge of the most useful instruments in the mathematical line; and any ideas that he commits to paper on the subject of mechanism I consider to be worthy of notice: and I hope you are of the same opinion. If so, I should be very happy to see it published in the next Number of the Philosophical Magazine.

I am, sir, with true respect,
Your obedient servant,
James Allan.

February 19, 1812.

[COPY.]

To Mr. Allan.

Sir,—I have lately seen in the Retrospect (No. 30) of philosophical, mechanical, &c. discoveries, some very strange remarks in the observations on the improvement on the Dividing Engine made by you, which I am clearly of opinion must have had their foundation in prejudice or extreme ignorance, or perhaps both. Here I shall not enter into any detail or vindication of what I said respecting my opinion before the Gentlemen of the Society of Arts, of the great perfection, I believed, and do still believe, that may be produced from your plan of racking or cutting the teeth of a circle for the purpose of dividing mathematical instruments. However, by way of explanation, I will slightly

slightly touch on a few points as a corroboration of my former opinion.

When the wooden model of the wheel and ring was first put into my hands at the Society's house, I immediately saw the great utility of the ring. I am still in the same opinion, that the principle, which is not attended with any great degree of difficulty in formation, will be found to produce that accuracy which I think is not likely soon to be excelled. The great improvement which has been made in lathes for turning large work would render that part of the operation quite easy, even if it was carried to six feet or more in diameter. A partial expansion at the time of racking, seems to me one of the greatest objections that can be made to a large size, and the bad effects of that I believe might be overcome.

To that extraordinary remark in the Retrospect, saying, "We can conceive cases in which the effect of the shifting would be to diminish the size of one or more of the teeth each time below that of the rest, instead of equalizing them, and finally, to cut some of them away entirely," I shall make no reply; only, that it cannot take place without an error of at least one whole tooth, before the shifting of the ring. Any man that knows the principle of a wheelbarrow will see the absurdity of this remark in a moment.

I hope it is mentioned in the Transactions of the Society of Arts, that when under the operation of racking or forming the teeth, the ring must, after being reversed or moved 180° once or twice, which will produce correctly all the way round opposite teeth, although unequal in themselves, be shifted one quarter or 90°; and then proceed with the racking and reversing as before, which will in the end, I have no doubt, provided all the work and apparatus concerned is good, produce the number of equal teeth required round a circle, for the purpose of dividing mathematical instruments probably not yet equalled. I have had some experience in these things, which I hope will allow me to speak with that confidence I do on this point. The instrument alluded to in the Retrospect is the first essay on the art of dividing by the rack and screw, brought forth by Dr. Hook in the year 1674, was merely a quadrant for the purpose of astronomy, with teeth cut with a screw all the way on the outer edge; which was not into degrees and minutes, but their true value was to be found afterwards: therefore it was not intended as a machine to divide

others

others with. The plan was soon abandoned by the Doctor on account of its inaccuracy. As far as I was ever able to learn, I believe my old master, Hendly of York, was the first that ever made an engine to work all the way round by a screw, to divide with. It was about 13 inches diameter, and cut into 360 teeth or degrees. I have worked with it many a day, both in the dividing and cutting down way.

Mr. Smeaton saw it in the year 1741, and he has told me since that he believed it was made about two years before that time. Now 72 or 73 years.

Now I will on your plan, just in a few words, run over the whole of the operation of making the teeth. All the apparatus being prepared and quite ready for the cutting part, I would first start on Ramsden's plan by the dots, one half or nearly of the whole depth of the teeth. This done, the screw has now got a firm hold of the teeth, and plenty of room for correcting by the ring, before the finish, any inequality that can exist in the complete circle. Having arrived at this point, I consider the work in a forward state, and the difficulty all over. So much accomplished, I would proceed no further on Ramsden's plan, but would have recourse to the correcting ring, proceed with the racking and shifting in the manner described above. Towards the last I would shift the ring every time it was once worked round by the screw cutter. By this moving the ring to half and to quarters alternately, all those errors will be perfectly corrected without much attention of the workman.

The Retrospect says you have given no proof, but bold encomiums on the perfection of your instrument, and denies its self-evidence. I really do not know any greater test that it can be put to than may be done by the ring, which is certainly a part of the machine.

I am confident in my own mind, that with making some little change, the whole of this piece of business, I mean cutting or racking the teeth truly, might be accomplished to the greatest degree of exactness, without steady pins or even lines (only a few pencil marks) by contact itself, which Mr. Smeaton says, and seems to have proved, in the Philosophical Transactions of the year 1785, is fifteen times nearer the truth than coincidence. Respecting your improvement in the dividing engine, by what I have said above, you will perceive that I still support my first opinion, that it is a great and important discovery;

and remain, sir, yours truly,

JOHN STANCLIFFE.

Little Mary-le-Bone Street,
Feb. 10, 1813.

P.S.—I

P.S.—I must say this, that I think the Gentlemen of the Society of Arts, &c. are very unhandsomely treated by the critic to whom I have alluded, as if they exercised no judgement on whom, or for what, they bestow their honourable and bountiful rewards.

XIX. *An Answer to the Observations of Dr.* Pearson *(see our last Number) on certain Statements respecting the alkaline Matter contained in dropsical Fluids, and in the Serum of the Blood. By* Alex. Marcet, *M.D. F.R.S. one of the Physicians to Guy's Hospital.*

To Mr. Tilloch.

Sir, Although I feel disinclined to engage in any public philosophical controversy, especially when the object is to vindicate statements, the truth of which any common observer may easily ascertain by experiment; yet, as there are some points in the above communication which do not place the question in its proper light, and might mislead those who have no opportunity of referring to the original documents, I have thought it necessary to offer in return a few observations. The state of the question is simply this: all chemists have for a long time agreed that the blood, and probably all the animal fluids, contain, together with various neutral salts, a certain portion of alkali not combined with any acid. This alkali has generally been considered as being soda, although a few chemists had also noticed traces of potash in some of these fluids. Dr. Pearson, on the contrary, in examining various kinds of animal substances, and especially of expectorated matter, was led to conclude that the whole of the uncombined alkali contained in the animal fluids, was potash; and that they did not contain uncombined* soda in any proportion whatever.

In analysing the fluids of dropsy, I was naturally led to inquire into this question, and the results obtained induced me to conclude, that the only uncombined alkali present in the blood, or other animal fluids, was soda; and that the indications of potash, which by applying the test used by Dr. Pearson I was able to detect in these fluids, were owing to the presence of that alkali in a state of combination with the muriatic acid.

The experiments I adduced in evidence were of two

* By the expression *uncombined*, I mean not combined with acid.

kinds;

kinds; some of them showing that the uncombined alkali was soda, and others that it was not potash.

Portions of saline matter being procured from various animal fluids by evaporation and incineration, and brought by subsequent redissolution and evaporation to a crystalline state, crystals of determinate forms were obtained, some of which appeared to consist exclusively of subcarbonat of soda, some of muriat of soda, and others of muriat of potash; but none could be detected which appeared to contain any carbonat of potash.

Other similar portions of the saline matter being treated with acetic acid, in order to bring any uncombined alkali present to the state of acetat; and alcohol being added with a view to separate these acetats, the residue of this alcoholic solution appeared to consist almost solely * of acetat of soda; whilst, on the other hand, potash was found in the residue left undissolved by the alcohol.

In these various trials the presence of potash, in a state of combination, was proved by the tests of oxymuriat of platina and tartaric acid, both of which form precipitates with potash, and not with soda.

The uncombined alkali, on the contrary, was shown *not* to be potash by the last-mentioned tests failing to indicate the presence of that alkali; whilst, on the other hand, it was proved to be soda by the action of nitric acid, which, in combining with it, formed crystals of a rhomboidal instead of a prismatic figure.

I shall not enter into the particulars of these operations, because they are minutely related in the communication which has given rise to this discussion; but I shall now rapidly examine the principal objections which Dr. Pearson has made to the above conclusions.

Dr. Pearson's first ground of complaint is, that instead of showing his conclusions to have been erroneous, that is, I conceive, instead of following him step by step in his inquiry, I have contented myself with exhibiting my own experiments and conclusions. But I beg to observe, that the object of my inquiry was not to repeat Dr. Pearson's experiments, but to examine dropsical fluids; and that, if in the course of my analysis I met with results which militated against his conclusions, it could not be reasonably expected, that in stating these results I should think it incumbent upon me to wade through his laborious

* A trace of potash was detected in the alcoholic solution; but it must be remembered that alcohol, however rectified, will take up minute portions of muriat of potash, or indeed of almost any other soluble salt.

researches

researches on the various forms of sputum or expectorated matter. I might indeed have abstained altogether from referring to his labours; but I thought it due to him, as a philosophical inquirer long known in the chemical world, to point out such similarities or discordances of results as occurred in our respective experiments; thus referring the matter to the decision of physiologists, and showing that there was no wish, on my side, to overlook the authority of former inquirers.

In endeavouring to analyse the various objections brought forward by Dr. Pearson, I am so often at a loss to understand his meaning, and, I must add, so much embarrassed by the obscure and inaccurate manner in which he has stated some of my own proceedings, that it would be a task equally fruitless and laborious to follow his steps closely. I must, therefore, as much as possible, select those objections which are of a specific nature, and may be answered by an appeal to experimental evidence. Such is, for instance, the argument which he employs, no less than three times, (once in support of his own experiments, and twice with a view to invalidate my inferences,) on the effects of alcohol and acetic acid,—which argument is founded upon his belief that acetat of soda is *not* soluble in alcohol, and that it is *not* a deliquescent salt; two palpable errors, which half a grain of this salt and a few drops of alcohol, with no other apparatus than a watch-glass, would have enabled him to rectify.

But the objection which recurs most frequently, and that upon which the greatest stress is laid, is the minuteness of the quantities of saline matter subjected to experiment. It would appear that Dr. Pearson questions whether a few grains of saline matter may be expected to yield results similar to those which would be obtained from larger quantities; whether, for instance, the same inferences might be drawn from rhomboidal crystals of a minute size, as from similar crystals of larger dimensions;—or, whether experiments tried upon an ounce or two of my dropsical fluids, may be brought into competition with those which he performed upon two or three pints of his ropy sputum?

Such a scepticism, I must own, I have myself never entertained. I have always thought, on the contrary, that the chemical properties which belonged to a particle of matter were exactly similar to those which would be found to belong to a whole mountain of the same substance; that a rhomb of only one hundredth part of an inch might be characterized by its form as distinctly as one a hundred times

times larger *. But I carry the point still further; for I go the length of believing, that many experiments of research may be wonderfully facilitated by analysing upon a small scale—that a great deal of convenience, of œconomy, and sometimes even of accuracy, may thus be gained; and that, in some instances, we even acquire new powers of inquiry by operating upon small quantities †.

Thus, were it not for the assistance of minute microscopic observation, a great number of important facts which have enriched chemistry within the last twenty years, would in all probability have remained undiscovered; and this country might not have obtained that first rank in philosophical chemistry, to which it has but lately been raised, and which it had long held in other departments of science.

Is it necessary that I should specify particular instances? Can any philosopher, attentive to the progress of analytical chemistry, overlook so many discoveries in which neither furnace, nor forge, nor subterraneous laboratories, have been concerned—in which a watch glass, a blow-pipe, and a few drops of chemical re-agents, have been all the instruments required? Were not, for instance, the analyses of the Iceland springs by Dr. Black (the same eminent philosopher to whom Dr. Pearson appeals as an authority against microscopic observations) performed upon quantities of saline matter of astonishing minuteness?—Surely Dr. Pearson cannot have forgotten that it was by the accurate examination of only a few grains of matter, that the nature of no less than five kinds of urinary calculi has been ascertained, and their discrimination rendered easy and certain—that the nature of diamond has been established—that no less than four new metals have been discovered in the crude ore of platina—that the similarity between all the

* Thus, I have no hesitation in maintaining that, unless it be proved that nitrat of potash may crystallize in rhombs, my conclusions respecting the particular point in question, would stand upon that evidence alone; or that unless it be shown that carbonat of potash may crystallize in cubes, my inference respecting the presence of muriat of potash stands uncontroverted.

With regard to my attempt at expressing centesimal parts of grains, which is, with some apparent reason, noticed as an instance of singular pretension to accuracy, I beg to observe, that I have never actually attempted to weigh smaller quantities than decimal parts of grains; and whenever smaller fractions have been expressed, they have arisen from a conversion of those numbers to some general standard.

† I would also observe, whilst upon this subject, that there is a degree of neatness gained by reducing the scale of operations, which is often incompatible with processes conducted in the large way: thus, I have never found it necessary, in analysing, to introduce amongst the enumeration of contents "a little dirt," as some old-school chemists have been in the habit of doing.

meteoric

meteoric stones has been proved—that the identity of the chemical agencies of electricity, whether excited by the common machine, or by the Voltaic battery, has been demonstrated—that in a neighbouring country the formation of crystals has been explained upon systematic principles—that amongst us a new and wonderfully accurate instrument of crystallography has been invented—and above all, that the metallic bases of alkalies, those extraordinary bodies which nature had hitherto concealed under an impenetrable disguise, have at last been brought to light! Let it be remembered as one of the most glorious circumstances of that discovery, that it was by examining mere atoms of these substances that their properties were first ascertained; and that when, in consequence of subsequent improvements in the mode of obtaining these bodies, they were procured in larger quantities, and their general properties were re-examined, no error was discovered, and no important information was added to that which had originally been gained from microscopic quantities.

It is far from my intention, however, to contend, that, on some occasions, new and important facts may not be brought to light by means of processes conducted upon an extensive scale, which would not admit of being reduced to a small compass. I only mean to assert, that such instances are comparatively but rare; and that no philippic against the examination of small objects—no appeal to old masters—no slight upon modern improvements, ought to deter chemical inquirers from adopting methods which some of our contemporaries have employed with so much utility and success.

Amongst other inaccuracies in the critique which has given rise to these remarks, my paper on dropsical fluids has been represented as being the joint work of Dr. Wollaston and myself; for which supposition there was no other authority than a note in the paper in question, in which I acknowledged my obligations to Dr. Wollaston for the information and assistance which I have on this and other occasions, derived from his kindness. I need not say how highly I should have been flattered by such an association; but I think it due to him to state, not only that he had no share in the general inquiry, but that he did not even see the paper in question previous to its publication.

I cannot refrain from noticing, amongst Dr. Pearson's remarks, another kind of licence which appears to me still less warrantable. I allude to the practice of quoting in italics, or placing between inverted commas, words or phrases

phrases which have not been used, and to seize upon them as a subject of ridicule. This is the case with some proposed *elegant* changes, and with my supposed recommendation to transfer chemistry to the "fire-side of the drawing-room:" expressions which I have not used, and yet upon which Dr. Pearson has thought proper to be extremely jocular.

I have only further to add, that should Dr. Pearson again write upon the subject, I shall not easily be induced to resume the controversy. I am sorry, therefore, to see it intimated at the conclusion of his paper that he proposes to continue his observations in your next Number; and as it appears that those intended remarks are meant as a return for the notice which I have taken of his papers, I regret the more that he should take so much trouble. For praise, when used as the vehicle of irony, is the worst kind of censure. The discovery of truth ought to be the only object of philosophical discussion. There are, doubtless, many errors in my humble attempts at chemical analysis; but unless Dr. Pearson points out those errors, or brings forward new facts connected with my inquiries, I confess that I had much rather he would not again honour them with his notice.

"Quicquid id est, timeo Danaos et dona ferentes."

I remain, sir, &c. &c.

Russel Square, Feb 21, 1812. ALEX. MARCET.

XX. *Description of the Diacatoptron. Communicated by Dr.* GIBBES, *of Bath.*

VARIOUS optical instruments have been applied to the purposes of drawing and copying, and have been carried to a great degree of perfection. The Camera obscura, the Delineator, and Camera lucida, have severally been justly celebrated for the facility of tracing outlines, and the rules of perspective have been correctly illustrated by these representations of natural objects on a plain surface.

The great simplicity of the instrument now about to be described, may entitle it to rank among the most useful of the kind, as, to the advantage of its simple structure and applicability without straining the eyes, it adds a degree of truth not to be exceeded. Without the aid of additional reflecting surfaces, this instrument represents its objects as an ordinary mirror, at the same time that it allows sufficient transmitted light to pass for the guidance of the hand behind it. Thus, by a very little management, both the hand

hand directing the pencil, and the object to be traced, may be equally well defined and clear. Another advantage possessed by this apparatus is, that very little light is lost, as is the case where many glasses intervene between the object and its representation. The application is also immediately obvious to the most careless observer.

Take a perfectly clear piece of glass, a foot square, well polished and quite even, and parallel throughout; place this in a frame (Pl. III. fig. 1.) about one inch and a half wide, and one inch thick, and instead of wood at the bottom of the frame place a brass wire or narrow and thin plate which will hold the three sides together, and prevent the glass from falling out, as it must rest on the wire or plate, which should be fastened tight to the feet of the frame.

The feet must be exactly at right angles with the frame, so that when the plate is placed upon an even table, it will stand perpendicular. In the upper part of the frame at *b*, make a long groove, in which insert the brass sight an inch broad (fig. 7.) having the small eye-hole *c*: this is to be fastened at top by the screw *d*, which may be screwed up or loosened at pleasure.

Divide the frame (fig. 5.) into two equal parts, beginning at the upper part from the groove *b*, to the bottom of the feet *a*, or of the brass wire. Divide again the lower part from *e* into eight equal parts, and on each side of the frame bore holes, taking great care to place them exactly at the eight measured points.

A board (fig. 6.) is called the table, of the breadth of the frame, in which two brass pins are fastened of such size that they may exactly pass into the holes to raise the table to different heights corresponding with the holes in the frame; otherwise you cannot magnify or diminish objects correctly according to the size you may wish to obtain. On the opposite side of the table are supports at each corner, so placed that they may be conveniently pushed up or down. The supports pass through two holes in the table, and in each are eight small holes of the same size as those in the frame, so that by means of a brass wire under the table it may be kept fast in a horizontal position.

The blind (fig. 2.) is made of a piece of wood, bevelled, one foot long, one inch and a half wide, and one inch in thickness. A brass or iron rod is bent in such a manner as to form a square, and the wood serves as a support to it. This frame is then covered with writing paper, which should be of moderate thickness. When you make use of the apparatus, place the object *h* upon a flat table on a level

with

with the window; on the right hand lay some blank paper, upon which a person may draw; and between the two place the *Diacatoptron* or transparent reflecting plate of glass in its frame; place the blind k at right angles with the glass on the right hand, so that the drawing paper may lie in the broken shade, and a person looking through the glass from the left side will observe the object exactly designed upon the paper. If the figure is not sufficiently distinct, you may darken the blind by hanging a paper upon it; if it should darken too much, you place it a little further from the glass.

It is of much consequence that the proper degree of shade should be thrown upon the paper; for, if it is too dark, you will neither see distinctly the lines of the drawing which you copy, nor the point of your pencil: if, on the contrary, it is not sufficiently dark, you will work at random, and the representation will be faint. In copying after this manner you do not make use of any eye hole, because the eye is easily kept in the proper direction, as the drawing remains in its appropriate situation; but in the following experiments, where the objects are diminished or magnified, whether a picture or prospects in perspective, the eye hole must be always used, since it is necessary to look exactly and constantly at the same point of view.

The diminishing of an object is effected by raising the height of the table. Since the object placed on the left side of the glass is always represented on the right side, although the surface of the table should not be of an uniform height, it will be found that, if you take a fixed point of view, the object will be diminished the nearer the reflected image approaches to this point, and will be magnified as the reflected and transmitted image is made to recede from the eye. Or rather, the image will appear larger than the object when it is removed further from the fixed eye than the object itself, and *vice versâ*.

This may be seen clearer by fig. 5. The parallel lines 1, 2, 3, 4, 5, 6, 7, 8, represent the different heights of the table. If now the line h were to be diminished, it would be reduced $\frac{1}{8}$ upon the table at 1, $\frac{1}{4}$ at 2, $\frac{3}{8}$ at 3, and at 4 $\frac{1}{2}$, as is shown by the lines of sight where the parallel lines intersect.

Fig. 3. represents the Diacatoptron when the letter B is diminished $\frac{1}{2}$; the table with the paper is placed in the fourth hole.

Fig. 4. represents the magnifying of an object when the table is on the left side.

In both cases you must look at the object through the eye

eye hole which is on the left. By this method of diminishing with the Diacatoptron, it is easy to take in prospects and objects in perspective.

Make a board (fig. 8.) $2\frac{1}{2}$ feet long, and bore two holes six inches from one end of the board at the width of the Diacatoptron, so that the supports of the table may pass through and may be placed upright. Fasten behind two perpendicular pieces of wood *a*; and also at the upper part two props which may pass into the holes of the table, into which the feet were before fixed, so that the table may be secured both at the top and bottom, and all shaking prevented.

Bore holes in the board from *c* to *a*, that you may place there the sight-piece *e*, which is either made of brass or wood, about six inches high, and has at the top a round brass plate one inch in diameter, in which is the eye hole.

When you make a trial of it, fix the paper fast on the table according to fig. 9. Place the Diacatoptron about six or eight inches from it, upon the board, and parallel with the table; the blind, (fig. 10.) which is made of wood, pasteboard, or paper, then covers the space between the Diacatoptron and the table, so that the opening *g* may be on the right hand; the sight-piece *e* is then so placed in one of the holes that you may have the desired power of diminishing, taking care that your head may not intervene between the object and the glass, and you may easily draw upon the perpendicular paper the objects diminished. In this way you may with ease draw plants, and in short all objects, even academy figures, &c., and under circumstances in which the Camera obscura could not be conveniently employed.

XXI. *Proceedings of Learned Societies.*

ROYAL SOCIETY.

Thursday Feb. 6. THE Society again met, when a short paper by Dr. Wollaston was read on the primitive form of calcareous, bitter, and iron spar. The composition of these three kinds of spar being essentially different, although their primitive form has hitherto been admitted to be the same, seemed to militate against the truth of the crystallogical system. Haüy himself having rather hastily allowed that the angle of the rhomboid of calcareous spar, magnesian spar, and iron spar, being 101° 27′, formed an exception to the general principle that a difference of constituent parts produced a difference of form, Dr. W. with his goniometer was induced to examine these spars with greater attention.

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The angle in all of them he found some degrees more than M. Haüy; and also that each had a distinct measure, which in whole numbers may be stated at 105°, 106°, and 107°. Hence he was led to the very important conclusion, that a difference in constituent principles does in every case produce a difference of primitive form; that the exceptions to this general position are entirely owing to errors in our crystallographical operations, and that the crystallogical theory is more true to nature than even its author had supposed.

Feb. 13. A paper by Mr. John Davy, communicated by his brother Mr. Davy, was read. MM. Gay-Lussac and Thenard and Mr. Murray have asserted that there is no action between gaseous oxide of carbon and oxymuriatic gas or chlorine, when they are exposed to sunshine. Mr. John Davy states in this paper a very different result—that the two gases combine and become condensed to half their volume, and form a peculiar new elastic fluid possessed of acid properties. He gives an account of the nature and combinations of this substance, which neutralizes four times its volume of ammonia, and forms with it a peculiar salt; it is not disengaged from ammonia by acetous acid, nor by sulphureous acid, and it is decomposed by the metals into gaseous oxide of carbon and chlorine, so that its constitution is established both by analytical and synthetical experiments.

Feb. 20. Another paper by Mr. John Davy was communicated to the Society by Mr. Davy. It related to the combinations of certain metals with chlorine and oxygen, and contained some general views on the theory of definite proportions. The pure combinations of metals with chlorine resemble in many respects oxides; they are non-conductors of electricity, many of them are very volatile, and they form muriates by decomposing water. Mr. John Davy describes two combinations of copper and chlorine, one containing twice as much chlorine as the other. Two of iron and chlorine, one containing half as much as the other. And two of tin and chlorine, of which the second contains double as much chlorine as the first. Bismuth, antimony, arsenic, zinc, lead, he has been able to combine with chlorine in one proportion only. Between the oxygen in oxides and the chlorine in these combinations, the rate is as 7·5 to 33·6. Many of these combinations with chlorine combine with oils: and Libavius's liquor, the compound of chlorine and tin, inflames in acting upon oil of turpentine. As the oxides are soluble in acids, so likewise are these compounds in an acid that they cannot decompose. Corrosive sublimate forms a particular salt, by combining with muriatic

 acid,

acid, and there are other analogous substances. Mr. John Davy considered the whole tenour of these experiments as offering confirmations of the fact that oxymuriatic gas, or chlorine, has not yet been decompounded, and that it is a solvent and acidifying principle analogous to oxygen.

ROYAL INSTITUTION.

Mr. Davy's Lectures on the Elements of Chemical Philosophy.

Mr. Davy delivered his second lecture on Saturday, Feb. the first. He offered some general views concerning the different modifications of matter, and the active powers engaged in the production of the phænomena of nature and of art; he then directed the attention of his audience to heat, or calorific expansion. He considered its important and diversified agencies in the œconomy of things; and after an elaborate discussion concerning the mechanical and chemical hypotheses relative to the nature of heat, he concluded by defining the limits of our knowledge on the subject.

The expansive energy, or power of repulsion producing heat; and attraction, which is either gravitative, chemical, or electrical, being one of the active powers belonging to matter, which cannot be separated from it—matter itself may be considered as inert, and all the harmonious arrangements in the heavens and the earth may be regarded as flowing from one primary cause, which, as it is intelligent, says Mr. Davy, must be divine.

The Professor entered into particular details relative to the effects of heat, its importance, and the laws of its operations. The law of expansion is connected with the equalization of the temperature of the globe, the production of winds, and the preservation of animal and vegetable life. He particularly pointed out its application to the ventilation of mines, and the heating and ventilating of rooms. He exhibited a model, illustrating the manner by which the House of Lords is ventilated and warmed, after a new plan proposed by himself. All the air deteriorated by respiration or combustion in the house, finds a ready exit by means of three copper pipes carried to the roof, and ultimately meeting in a single pipe; the circulation of the air is assisted by a furnace, and by means of ventilators below there is a constant supply of fresh air. Such a plan Mr. Davy conceives might be adopted in large drawing-rooms, or in crowded assemblies, with excellent effect and at a trifling expense.

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The formation of elastic fluids arising from the decomposition of vegetable and animal matters, proceeds very slowly under pressure: in illustrating this principle Mr. Davy referred to the method lately adopted by M. Appert for preserving meat or vegetables, which consists of enclosing them in close tin plate vessels, excluded from the contact of air. Putrefaction cannot proceed unless aëriform fluids escape. Mr. Davy conceives that this method may be improved by using stronger vessels, and compressing into them a quantity of fixed air, which by its pressure and chemical properties would prevent decomposition.

In illustrating the effects of combustion, Mr. Davy noticed some recent experiments made by Count Rumford, who conceives that the light emitted is proportional to the heat of the flame, and that it may be greatly increased by bringing several parallel wicks near each other. A model of what the Count calls a polyflame light was exhibited. It had four wicks, and the Count states that a lamp of this kind, when properly constructed, will afford as much light as 50 wax candles.

Mr. Davy concluded his lecture by explaining the phænomena of heat on the mechanical hypothesis of its being a vibratory motion of the particles of bodies; and accounted for latent heat, when solids are converted into fluids, by supposing that the motion is employed to make the particles revolve round their axis. He offered this view, merely for the purpose of comparison with the idea of a specific fluid, the existence of which had often been too confidently advanced by some philosophers. On such a subject it was proper to doubt. The facts of science should be kept perfectly distinct from the hypothetical opinions advanced to explain them.

"The truly philosophical inquirer into nature," says Mr. Davy, "will not consider it as a disgrace that he is unable to explain every thing. He will feel that truth is more promoted by the minute and accurate examination of a few objects, than by any premature attempts to form grand and universal theories."

Mr. Davy delivered his 3d Lecture on Saturday, Feb. 8, (it was upon chemical attraction). After stating that the most important phænomena of chemical change depend upon the operation of chemical attraction, and on the agencies of heat, the Professor said it would be necessary to enter into a discussion of the laws of attraction, and to illustrate them by experiments. This discussion, he said, might appear minute and tedious; but it was essential, as the subject was the scaffolding by which the edifice of chemical

mical philosophy was to be erected; and it should therefor be constructed with care. Mr. Davy mentioned that chemical attraction was the power by which different bodies unite with each other and form new and different substances; that some bodies possess no chemical attraction, and others exert it with different degrees of force; which he illustrated by experiments. He said, the law of combination, or the union by chemical attraction, applied to all the different ponderable forms of matter; fluids not only produce solid matter, but sometimes likewise gaseous matter; and gases are condensed into fluids or solids: he instanced the combination of aquafortis, or nitric acid, with alcohol; also olefiant gas and chlorine; likewise sulphureous acid gas with ammonia; and proved, that as their forms and properties were visibly changed, so likewise were their other sensible qualities. He next referred to his introductory lecture, in which he mentioned that bodies which attract each other unite in definite proportions. This law, said the Professor, is perhaps the most important of our science, and admits of elucidation by a number of experiments. He showed the combinations of barytes and sulphuric acid, chlorine and hydrogen, hydrogen and oxygen: they always unite in definite proportions. Mr. Davy showed also some experiments on the combination of muriatic acid gas with ammonia. This experiment, he said, was mentioned lately in a monthly publication, by Mr. Murray, to prove the presence of water in muriatic acid gas; but the Professor clearly proved, that the presence of water was owing to the hygrometric qualities of the salt, which, when exposed to the atmosphere for an instant, absorbs moisture directly; and he showed an experiment, in which, when muriatic gas and ammonia were combined out of the atmosphere and heated, not an atom of water could be procured from them. Nature acts by this fixed and immutable law; and her arrangements, said he, however diversified, follow a certain order; the circumstances of crystallization and definite proportion form the alphabet by which her chemical language is to be deciphered; and it is not composed of numerous hieroglyphics, but of a few simple characters. Mr. Davy said, that when two bodies combine in more than one proportion, still their proportions are definite, that the second proportion is always a multiple or a divisor of the first; he instanced mercury, which combines with two proportions of oxygen, the second oxide contains double the quantity of oxygen of the first; also fluoric acid, which combines with ammonia in two proportions, viz. one in volume, and two in volume; so that the first contains

tains half as much alkali as the second: also Dr. Wollaston's experiment of equal weights of carbonate of potash, one fused, the other in its common state; the one containing exactly half as much gas as the other. He said it was in consequence of these circumstances, that whenever compounds decompose each other by double affinity or double attraction, there is always merely a new arrangement of their elements, and none of the substances are found either in excess or deficiency: he instanced the salt called nitrate of barytes, which, when mixed with an equal weight of that called sulphate of potash, the potash unites to the nitric acid, and the barytes to the sulphuric acid, and the results are neutral as before. It is, said Mr. Davy, in consequence of this simple law, that whenever one body precipitates another from its solution, the same quantity of one always precipitates the same quantity of the other; and hence the different chemical elements may be expressed by numbers, and all their combinations be represented by the simple addition of those numbers. Some of those principles, said he, may appear abstruse; but if the proportions be considered as uniform parts, there can be no difficulty in understanding the doctrine. On this part of the science, said the Professor, it is necessary to gain distinct ideas; the doctrines of chemical affinity become the instruments for comparing the results of our experiments, and their deviation from or coincidence with the law of proportion are the tests of their accuracy or imperfection. These doctrines, said he, are capable of being made the guides both to the practical and philosophical chemist; they teach the artist or manufacturer what proportions of substances are necessary for his combinations, and enable him to pursue new principles with precision and certainty.

Mr. Davy delivered his fourth Lecture on Saturday Feb. 15th. He considered and illustrated the principles of electrical science, as developed by the various combinations of human ingenuity, and exhibited in the phænomena taking place in the external world.

When resin, glass, &c. are rubbed by woollen, they first attract, and after contact repel, light substances. Bodies in such a state are said to be electrical. This property was first observed in amber, called *electron* by the Greeks, from which the term electricity is derived.

In the 16th century, the researches of Gilbert awakened the attention of philosophers. He considered electricity as exhibiting the attractive and repellent powers of matter. The sagacity of Newton pointed out these powers as peculiar forces.

Otto de Guericke, Boyle, Hawkesbee, &c. observed that luminous appearances were exhibited by electrified bodies, and for a series of years these novel exhibitions served rather to amuse scientific men than to direct them to the fundamental principles of electricity.

The discovery of Franklin, that lightning depends on the electrical state of the atmosphere, gave a new impulse to this department of knowledge; and the novel facts observed by Galvani led to the noble inventions of Volta. "The discoveries to which they led," says Mr. Davy, "have produced a new order and arrangement of facts, and have to a certain extent connected together mechanical and chemical science, and exhibited new and unexpected properties of material bodies."

The Professor said, that in treating of the subject he should offer views different from any that have been developed by elementary writers on electricity; but no apology was necessary, the progressive nature of science is one of its noblest characters. As the facts of electricity have multiplied, the theory is more capable of being simplified; a number of effects formerly supposed to be insulated may be attributed to the same cause.

Mr. Davy described the different modes in which electricity is excited, by the contact of bodies, by friction, by heat and changes of their form; and this property seems to belong to all material substances.

In the mineral kingdom there are several stones which exhibit electrical effects by being heated, as the tourmaline, boracite, &c. Dry vegetable substances and most crystallized bodies produce these phænomena by friction, and the metals by contact. Thus zinc made to touch mercury becomes positive, the mercury is negative. The case is the same with other metals, as gold and mercury, copper and mercury, &c. Even fluids and metals produce similar effects, as in the case of liver of sulphur and copper.

The electrical effects produced by the contact of different metals are less obvious than those connected with luminous appearances; but they may be perceived by the sensations, or by the effects produced on the limbs of cold-blooded animals recently deprived of life, as in the celebrated experiment of Galvani, who conceived that the effect was produced by a specific subtile fluid; but the genius of Volta, said Mr. Davy, proved that it was electrical, and gave the demonstration of its principles in one of the noblest inventions ever produced by human sagacity.

"Very slight circumstances," said the Professor, "are sufficient to develop these important powers of matter, and they

they must be continually in operation in external nature; their grandeur and sublimity are exhibited in the thunder storm; and in their more tranquil agencies they minister to the order of the terrestrial system, and perform slowly and silently important functions in the œconomy of things."

Electricity, by influence or induction, is different for different substances; and the phænomena of electricity, by influence, exhibit the difference between conductors, imperfect conductors, and non-conductors. It is also on the principle of induction, combined in some cases with that of primary excitation, that the powers of the instruments for accumulating electricity depend, as in the Leyden jar and Voltaic apparatus.

Mr. Davy exhibited the powers of the Voltaic instrument by some brilliant experiments; medals were fused upon the surface of water and oil of turpentine, and burnt in contact with them. He stated that the maximum of heat was at the positive electrical surface; and he exhibited an experiment in which, though the most brilliant light was at the negative surface, yet the ignition was infinitely greater at the positive.

The Professor pointed out the analogy between the Voltaic battery and the organs of the torpedo and gymnotus. "These mean animals," said he, "in the bosom of the waters, are found armed with the power that produces lightning and thunder. The more the resources of art are extended, the more analogies to them are found in nature, which offers, as it were, the archetypes of even our happiest and most extraordinary invention."

In speaking of lightning, the Professor said, that rods intended to preserve buildings from its effects should be at least half an inch thick, and coated at top and bottom with platina, to prevent the effects of the weather. They should also terminate, if possible, in a moist stratum of earth.

In considering the applications of electrical science to explain natural phænomena, Mr. Davy said, that the brilliant and astonishing discoveries made known in this science in the middle of last century, attracted the attention of speculative as well as of experimental philosophers; and attempts were made to explain all the great and extraordinary phænomena of nature by electrical agencies. "New principles," said he, "when first discovered, are always extended too far; the imagination, like the eye, is dazzled by novel and brilliant lights, and time is required before objects are seen in their true relations or proper colours."

The natural appearances which may with probability be attributed to, or supposed to be connected with, electrical effects,

effects, Mr. Davy considers, are water-spouts, some earthquakes, the luminous phænomena in storms, and the aurora borealis or northern lights. Lightning and the thunder-bolt, said he, were regarded by the ancients as the terrible instruments of the divine vengeance of heaven. The moderns, in developing their causes, have not only disarmed them of their powers, but have removed much of the superstitious fears which they occasioned, and have shown their uses in the œconomy of things. In the system of nature the obvious effect is often the least important, and that which seems evil, when distinctly considered, is found only to exalt the good and render it more impressive. Poets have given malevolent spirits to direct the storm, and have made it an instrument of vengeance and destruction; the philosopher, on the contrary, finds it guided by the ministrations of wisdom, goodness, and intelligence.

Mr. Davy's fifth lecture was delivered on Saturday, February 22d. He illustrated the laws of electricity by the great Voltaic battery, consisting of two thousand double plates of copper and zinc, of four inches square. He showed the identity of Voltaic and common electricity, and exhibited the decomposing agencies of the battery in a series of beautiful and impressive experiments, many of which were of a novel kind.

The identity of Voltaic and common electricity is demonstrated by the spark, the effects produced on the instruments employed for exhibiting electrical phænomena, as electrometers, the electrical battery, and on the organs of sensation. When bodies are similarly electrified by Voltaic as by common electricity, they repel each other; but when dissimilarly, they attract each other. The electrical battery was charged, and produced a spark by a single contact from the Voltaic instrument. The more the powers of the Voltaic battery are investigated, the more correct the original views of Volta appear concerning the identity of Voltaic and common electricity. Mr. Davy could not avoid reprobating the use of the terms *Galvanic* batteries and *Galvanic* electricity. Galvani was only the accidental discoverer of an important fact. Volta ascertained the true cause of the phænomena, and the merit of correct views and of sagacity peculiarly belongs to him. "Where the names of men are to be connected with science," says Mr. Davy, "truth should be rigorously attended to. Almost the only reward offered in these times to scientific excellence, is fame; and philosophical men should award it with the same justice to the living as to the dead."

Mr. Davy distinguished the chemical agencies of the battery

battery into two kinds—into decompositions by ignition, and polar decompositions. The former are exhibited when compound gases, fluids, or solids are submitted to the agency of the fire excited by electricity. The latter, when alkaline, earthy, or metallic combinations in a fluid state, or moistened with water, are acted on by the battery. Mr. Davy illustrated these different decompositions by appropriate experiments. Sulphurated hydrogen and olefiant gas were decomposed in glass globes by the contact of charcoal. These experiments were novel and impressive,—especially that on sulphurated hydrogen gas, the sulphur was precipitated in the form of a dense white cloud.

Mr. Davy decomposed soluble and insoluble compounds, as nitre, sulphate of barytes, &c. and in all decompositions he found that alkalies, metals, metallic oxides, and hydrogen, were uniformly attracted by the negative surface, and repelled by the positive surface; and that acids, oxygen, and chlorine were uniformly attracted by the positive and repelled by the negative surface. It was in consequence of the discovery of this law of decomposition, that Mr. Davy decompounded the fixed alkalies, the earths, &c.

Mr. Davy explained the transfer or passage of an acid through intervening alkali, or *vice versa*. In such cases the usual operation of chemical affinity appears to be suspended or destroyed by the agencies of Voltaic electricity. Mr. Davy pointed out the application of the chemical polar agencies of electricity, to obtain alkali from the decomposition of neutral salts.

In illustrating the fusing powers of the battery, the Professor stated, that the German philosophers were said to have converted charcoal into a substance analogous to diamond, by a powerful combination. The only effect which he had been able to witness in trials of this kind, was, that the charcoal became harder at the points of contact. He exhibited an experiment in which very fine points of charcoal were electrized in chlorine gas, but there appeared to be no indications of fusion.

Electrical decompositions and combinations, there is great reason to believe, are constantly taking place in the bosom of the earth and on its surface; and many of those phænomena, says Mr. Davy, which are attributed by contending theorists, either to the effects of water or fire, may possibly be owing to more refined agencies operating in the course of ages, and producing effects scarcely perceptible in the short period allotted to human observation.

The surface of the globe must be influenced by the electrical changes which occur in the atmosphere, and they may

may act an important part in the formation and renovation of soils.

To some, says Mr. Davy, these circumstances may appear too minute to be dwelt upon—but nothing which marks intelligence in the œconomy of Nature, he said, should be passed over without notice. We recognise, with feelings of pleasure, the combinations of ingenuity in human inventions; and surely the grand arrangements of Nature are worthy of our contemplation; and if we can feel sentiments of respect and obligation to the contrivers of artificial machinery, limited in purpose, feeble in effect, we cannot refuse the higher tribute of gratitude and devotion to the Author of the mechanism of the universe, where the scheme is designed by infinite wisdom and goodness, and executed by infinite power.

Mr. Davy stated, that the chemical attractions of bodies are nearly related to their electrical polarities; the chemical agents which act most powerfully on each other, produce the most striking electrical phænomena. The powers of all Voltaic combinations appear to be, in some measure, proportional to the chemical attractions of the acting bodies.

Mr. Davy stated, that he had been misunderstood relative to the ideas he formerly advanced concerning electrical and chemical attractions. He did not say that chemical attractions were produced by electrical attractions, or *vice versa.* He conceived that they may be different exhibitions of the same powers of matter, in one case acting upon particles, and in the other upon masses. He wished, however, not to attach much importance to this or any other hypothetical notion. Hypothesis, he said, should always be induction from experiments, and should be regarded as dangerous and unprofitable when it does not lead to new experiments.

GEOLOGICAL SOCIETY.

The annual general meeting of this Society was held on the 7th of February, when the following gentlemen were elected as Officers and Council for the ensuing year.

OFFICERS.

President.

George Bellas Greenough, Esq. M.P. F.R.S.

Vice Presidents.

William Babington, M.D. F.R.S.
Sir Abraham Hume, Bart. M.P. F.R. and L.S.
Sir John St. Aubyn, Bart. M.P. F.R.A. and L.S.
Robert Ferguson, Esq. F.R.S.

Treasurers.

Treasurers.

William Haseldine Pepys, Esq. F.R.S.
Samuel Solly, Esq.

Secretaries.

Leonard Horner, Esq.
Arthur Aikin, Esq.

Foreign Secretary.

James Lewis, Count de Bournon, F.R. and L.S.

COUNCIL.

The Council consists of the Officers of the Society, and of twelve other Ordinary Members.

The Ordinary Members for the present year are

Alexander Apsley, Esq.
The Hon. Henry Grey Bennet, M.P.
The Rev. E. J. Burrow.
John George Children, Esq. F.R. and L.S.
Samuel Davis, Esq. F.R.S.
Sir Henry Englefield, Bart. F.R. and L.S.
James Franck, M.D.
James Laird, M.D.
Alexander Marcet, M.D. F.R.S.
William Phillips, Esq.
Henry Warburton, Esq. F.R.S.
Samuel Woods, Esq.

Feb. 21st, 1812. An extract of a letter from Mr. J. R. Jones of Holywell to the President was read, giving an account of a specimen, presented by him to the Society, of supposed native lead, found in a bed of gravel in the neighbourhood of Holywell.

An extract of a letter communicated by the Hon. Henry Grey Bennet, member of the Geol. Society, was read, describing a submarine volcano which made its appearance on Feb. 1st, 1811, off the Island of St. Michael's in the Azores.

The reading of a paper by W. Phillips, Esq. member of the Geol. Society, entitled "A description of the oxide of tin the production of Cornwall; of the primitive crystal and its modifications, including an attempt to ascertain with precision the admeasurements of its angles mechanically, by means of the reflecting goniometer of Dr. Wollaston: to which is added, a series of its crystalline forms and varieties," was commenced.

The native oxide of tin appears to have been found in almost every district of Cornwall, and in the opinion of Mr. Phillips is by no means peculiar to the primitive rocks of that country. Particular crystalline modifications of this substance characterize particular veins.

Alluvial depositions of tin of considerable extent and depth have been found in several parts of Cornwall, which appears

appears to be the only part of Europe in which this metal occurs under these circumstances. The peculiar variety called wood tin has hitherto only been met with in these beds, or stream-works as they are termed in the country; and these have also furnished the only specimens of gold hitherto found in Cornwall.

Among the specimens of tin in the collection of Mr. Phillips, it may be observed occurring in granite, in mica slate, and in other varieties of schist, accompanied by chlorite, tourmaline, calcareous spar, schiefer spar, topaz, calcedony, quartz, fluor spar, and clorophane; yellow copper ore, blende, arsenical pyrites, and wolfram.

The following Donations were received:

Statistical Accounts of the Counties of Cork and Antrim. From the right honourable the Dublin Society.

Exotic Mineralogy, Nos. 1 to 6. From James Sowerby, Esq. the author, Member of the Geological Society.

Histoire Naturelle de la France Méridionale, par M. l'Abbé Giraud Soulavie, 6 vols. 8vo. From Dr. Laird, Member of G. S.

Specimens from Northumberland. From the Hon. Henry Grey Bennet, Member of G. S.

Specimens from Ireland. From G. B. Greenough, Esq. President of G. S.

LONDON PHILOSOPHICAL SOCIETY.

The objects of this Society are, according to its Prospectus, "those of every man who *loves improvement*:—to foster genius, to eradicate unphilosophic prejudice, to increase the knowledge of nature, and most, of man; to destroy, as much as possible, that false definition of words which has been justly reprobated by Locke and Bacon as the origin of sophistry and misconception; but, above all, to remove that barrier erected by pedantry against universal knowledge, which has introduced an *esprit de corps* into philosophy, and rendered it the territory of a sect rather than the province of the world."

The means which they adopt to effect these desirable purposes are, principally by the production of lectures in every department of philosophy, excepting theology and politics; and by a rigorous subsequent examination, in which Truth is the solitary object of devotion, and the inductive system of Bacon the portal to her shrine. This principle of responsibility imposed on the lecturer we believe to be perfectly original; and the good resulting from it must be con-

considerable; because, while it fosters the vigorous growth of original talent, it lops away the puny excrescences of plagiarism, and the decayed branches of false and unwarrantable hypothesis.

The attention of the Society has, for this month, been chiefly directed to a brief course of lectures on the Pyramids, by Mr. Clarkson, as a prelude to a regular attempt at illustrating the hieroglyphical language.

The first object of Mr. C. is to establish the point, that the Pyramids in question were not sepulchres, but temples dedicated to the mysteries of Solar Fire; and we think he has succeeded. Indeed, he has brought together such a mass of evidence from every possible source, from Arabian manuscript, Coptic tradition, Hindoo analogy, Greek record, various etymology, and logical deduction; he has condensed such an intense corradiation of proof, as we feel assured will scarcely fail, on perusal, to produce a simultaneous conviction. It is impossible for us to follow him through all the various channels of his research; it is sufficient to say, that part of his lectures was occupied with proving that the Pyramids were not sepulchres, and the remainder in arguing that the passages of those singular buildings were devoted to the mysteries of Fire. In pursuing the first of these divisions, he rests his conclusions on the following facts:—That the form of the Pyramids was sacred and mysterious; and this he proved by the pyramidal stones sacred to the Sun, to Hermes, to the Paphian Venus, and, in modern times, to Bramha.

He proceeds from this to trace the connection of this form with the geometrical philosophy of the Egyptians, which descended from them to the Platonists and Pythagoreans; and he imagines it scarcely probable, that a nation imbued with such a veneration for this form as the Egyptians were, would have consecrated it to the purpose of sheltering the body of a *single* monarch at an enormous expense. If this building were intended to neutralize the chemical properties of Nature in this body, as Napoleon was informed, he inquires, how it came that the builders left a hole of a foot in diameter, which perforates the wall of the second pyramid to the central room? If this body was that of Cheops, as it has been affirmed, how was it that Cheops, who despised the theology of the Egyptians, should spend a whole life in building a mausoleum which belied his own atheistical notions, and confessed his fears to be under the influence of the priests whom he despised? As to the Sarcophagus, he remarks, that six circumstances mark that it was never intended for a tomb. If it could neither be intro-

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duced by the common entrance passage, nor by the well, how was the body to be deposited within it? Would the attendants convey it in their arms? This was impossible, for a single man can scarcely penetrate one department of the passages—or would they drag it by cords? This was absurd to suppose, when the Egyptian veneration for the dead was called to mind:—and supposing this true, what was the use of so many passages so curiously contrived? Was it to increase the magnificence of the burial? This could not be; for the passages are in general only three feet and a half high, and only one of them leads to the upper room. Was it for the attendants, who, according to Maillet's theory, were buried alive with the dead monarch? This was ridiculous, for they were confined to a single room:—and for what purpose the two rooms, the five galleries, the platforms, and the well? And if the niche in the lower room were dedicated to the mummy of the queen, how came it that the unalterable laws of the Egyptian priests were violated at the same time, and in the same building? How came it that the body in the sarcophagus was placed horizontally, but the body in the queen's chamber perpendicularly? The six circumstances, from whence he infers his conclusion, are therefore, 1st, that it was impracticable to bury the body with any the least degree of decency in the sarcophagus; 2d, that the form was not likely to be given to the human body, being half the width of the length; 3d, that it was customary for the Egyptians to hollow the internal cavity of their real sarcophagi in the human shape, and this is not so formed; 4th, that it was a custom of the Egyptians to decorate them with hieroglyphics, and this is not so adorned; 5th, that it was likewise a custom of the Egyptians, depending upon invariable laws, to place them upright against a wall, and this is not so placed:—it may be said, that it has been moved; but it is fixed, and the attempt to dig for treasure beneath it, of which the testimonials still remain, proves that it retains its original position; and 6th, that the sarcophagus consists of two exact cubes; and this circumstance, combined with its mystic situation, which is precisely that of one of the foci of an ellipse, supposing an ellipse inscribed on the rectangle of the floor, substantiates clearly the fact, that its purposes were mysterious. To what purposes then, asked Mr. C. was it applied? to those of lustration, similar to the same vases in Hindostan? We have Tanks of this description, adds Mr. C., in the British Museum, and no one ever imagined that they were intended for sepulchres. He then proceeds with a just and sensible argument, drawn from the pyramidal Temples of India.

India. These temples, as he observes, bear the same external character, have similar internal passages, and yet no one ever imagined that these temples were mausoleums. Why then do we induce a different conclusion where the premises are the same? He pursues this argument by producing an extract from a Brahmin tradition, (*the Maha Calpa*,) which asserts that a Hindoo conqueror was the founder of the Pyramids, that the Sarcophagus was devoted to the mysteries of the Egyptian Isis, and that the well communicates with immense subterraneous regions,—a circumstance supported by another extract from an Arabian manuscript. We agree, however, with Mr. C. that although it is extremely probable that there was a legitimate entrance to the pyramid of Cheops; yet that, if it rested on the mere Coptic tradition recorded in the manuscript described, it would by no means be worthy of implicit credence. We give him credit for sacrificing speculation on this and on other occasions to prudence; and we think he has acted wisely in abstaining from the question, when the Pyramid was built? though it is settled by the manuscript at 300 years before the Deluge.

With regard to his etymological definition, though we entertain no greater respect for it than Mr. C. considered as affording illustration, we think that the Hebrew word *Pyramido*, the revelation of Perfection, or the Bull, is a much less strained analogy than *Booremith*, the cave of Death. It is curious, however, that the Coptic word *Meed*, which corresponds with the Greek *Mathos*, the Jewish *Mido*, signifies in Shanscrit a college of priests, and, when combined with the foregoing part of the word, implies that *Fire* was the object of their devotion.

To proceed: If it be proved that the Pyramids were not sepulchres, there appears to be no alternative but admitting that they were Sabean temples. But Mr. Clarkson is not satisfied with this position, singly considered, and has therefore entered into a variety of evidence to prove that the passages afforded the original model of initiatory caverns. After detailing at some length the exoteric and esoteric rites of the ancient nations with a degree of erudition which does him credit, he proceeds to adapt the description of these rites to the peculiar form of the pyramidal recesses. We copy this adaptation, because we consider it extremely ingenious; and though we are ready to admit that it bears a character of abstract speculation, we think, as he has established his main point, that the details de-

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pending on that point may be allowed a little clothing from a clasical imagination.

"It is sufficient for me to observe, on the admission of the foregoing premises, that the room situated in the exact centre of the Pyramid of Cheops, as the Sun is situated in the centre of that starry system of which the Pyramid is a symbol, must have been devoted to Osiris. Next, that the situation of the Sarcophagus, exactly placed on one of the foci of an ellipse, and formed of two exact cubes, both of which circumstances were symbols of the same meaning, was dedicated to the birth of Horus, or Light, one of the gemini who sprung from the egg of Chaos. Now the Gemini were like the Cherubim, the two visible apparitions of the Triune Principle; for, according to Pausanias, the number of the Dioscuri originally corresponded with the Cabiri. And here I cannot but remark, that, according to the Pythagoreans, in two minds, that is, Isis and Osiris, was contained the great generating Fountain of souls, and that Light and Life sprung from their mystical marriage. Now the Demiurgic principles of nature were represented by cubic stones. Hence the cubic temple of Mecca, hence the cubic stone of Bubaste. The temple of Solomon was indeed built upon a similar model; it consisted of three exact cubes, two of which were visible, but one invisible.

"For myself I have no doubt, although I may not be able to express my ideas so strongly as I feel them, that the Sarcophagus in question was devoted to the higher mysteries. We know that the Mosaic Tabernacle was formed upon a similar model; and that it contained, according to the Rabbins, the Sephyroth, that is, the Spheres or the Sidereal Gates, and the great Decad of the Law written on two stones. Now we are informed by Plutarch and Apuleius, that a Chest containing a golden Ark was used in the mysteries of Osiris. We learn from Synesius, that these Arks, according to the priests, contained the Spheres; those Spheres which were sometimes represented by semicircles, and sometimes by cubes; those Spheres, of which the Dioscuri, the Sephyroth, the Cherubim, (and even Proserpine, the object of Eleusinian initiation,) were alike the symbols. We are told, moreover, by Suidas and Eusebius, that Arks were devoted to the mysteries of Fire, and that they were considered sacred, as well as the triangular form, to the great triple Deity of Eleusinian as well as Egyptian initiation, Bacchus, Proserpine, and Ceres. But that nothing may be wanting to identify these Arks with the triangular Pyramid, the

the chamber of Osiris-Bacchus, and the Sarcophagus itself, Pausanias informs us that the *Image of Bacchus* was found in a Chest which was said to be the gift of Vulcan—that Vulcan of whom the Pyramid was a symbol—that Chest of which the Sarcophagus was a model—that Bacchus to whom the central room was certainly devoted. Finally, to complete the evidence, for it is impossible to turn without finding so many proofs as can scarcely be condensed into two Lectures, we hear from Plutarch, that on the third day after Osiris had been deposited in his Ark, during which time he was supposed to have descended into Hades, (the lower hemisphere of the astronomers,) they opened it, and brought forth a Heifer to the people as the Deity restored to life. Now the famous manuscript of Denon represents the exact point of time. The Sarcophagus on which the Heifer rises, is evidently the mystical tomb of Osiris, from the prostrate figure on the side and the triune symbol above; and it certainly agrees with the figure of the pyramidal Ark. I shall add, by way of corollary to this evidence, that the Hebrew word *Pyramido* signifies a revelation of the Heifer, as well as of Perfection, or of Fire.

"To proceed: The under room, still bearing the name of the Queen's chamber, was devoted to the mysteries of Isis; for that goddess bore the name of the Queen among the Egyptians. (*Diodorus Siculus.*) With regard to the niche in this room, it was probably devoted to a statue of Isis Multimammia, or the same triformed goddess exhibited at Eleusis. Maillet pretends that the mummy of a dead queen was deposited here. But I put it to the candour of antiquarians, whether, if I had stated that in the very same monument, and almost at the same time, the Egyptians, so tenacious as they were of invariable customs, so tenacious indeed that, even while they knew as much of the principles of statuary as the Greeks, they sacrificed the truth of proportion and of nature to the standard of monastic prescription,—that these priests should in one instance deposit the body horizontally, and in another perpendicularly, they would not have conceived it an insult on their understandings?

"To return from this digression, however, it must have been in the two first passages that the Aspirant was terrified and bewildered by the flickering lights, the groans, the cries, and the howlings of dogs. It was there, possibly, that a hundred terrible shadows, disgorged from the mouth of the well or from the grotto beneath, surrounded him with indescribable terrors. And here, were I desired to account for the holes in the central room, one of which extends to

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the outward wall, and the other to the foundations of the Pyramids, I should answer, with very little hesitation, that they were devoted to secret communication, and most likely to inform the assembled priests of the exact moment when the initiate entered the north angle, or the well. I consider this as a much more satisfactory and plain statement than that of Savary, who contends that one of them was intended to convey food to the visionary personages he here confined; for, according to his own hypothesis, it was scarcely possible to ascend the external wall; and it is not very probable that a set of priests, tenacious to a refinement of their secrets, should have suffered a basket of provisions to be dangling from a height of two hundred feet—a mere realization of Mother Bunch's Tales. But it is the constant feature of a forced hypothesis, that some little difficulty is perpetually starting which requires a correcting or a pruning hand. For myself, though I feel conscious that my powers of research are infinitely inferior to those who have preceded me, yet satisfied that I have yielded every thing to fact, and nothing to imagination, I am persuaded, that every candid and unprejudiced mind will submit to the weight of evidence I have adduced, and particularly to that harmony of feature which pervades and characterizes the system which I have endeavoured to erect with comparatively feeble powers, but with unremitting patience of investigation. Even the narrow communication between the first and second gallery, which has confounded and perplexed the opposite theorists, and certainly put them to their last shifts of explanation, is to me a matter of triumph and of aid. For I have only to read the ordinary descriptions of travellers, and the cause of it is apparent. We are compelled, they all concur, to strip ourselves at this point, and to crawl upon our bellies like serpents;—and behold two accredited steps of ancient initiation: for it is notorious that these actions, rendered necessary by the skill of the architect, are symbolical rites, representing at once the fall of man, and his willingness to return to his original simplicity and purity. Indeed, if the analogy were not so strong as it is, we are not deficient in evidence, drawn from the cave of Trophonius, St. Patrick, &c. which were built upon a similar model, that the narrowness of the passage was intended to impress a feeling of terror on the mystic votary. Proceeding, therefore, by the same analogical clue, the concession seems as it were exacted from us, that the five platforms and five galleries were the inferior gates of the great Sidereal Ladder which

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led the initiate to the central Sanctorum of Osiris. The Coptic manuscript says, that there were images of the Stars and the Sun and Moon within—but the arrangement of the passage speaks for itself. I have before proved that the Sephyroth, with its own gates, was an Egyptian mystery. It remains to observe, that all the ancient temples of which we have record, were built upon an astronomical principle. Of this, the temples of Mecca, of Solomon, of Elephanta, are proofs. Nay, there were pyramidal temples in Chaldea and Mexico, which were erected on the very principle of the Sidereal Ladder and the Sephyroth. There is nothing, therefore, overstrained in seeking for it in the Pyramids of Egypt, expressly dedicated to the Universal System. It must be recollected, however, that the Sidereal Ladder was not always uniformly represented. It was not in the two instances before us; one consisted of concentric circles, the other of steps. We know that the Jewish Sephyroth was sometimes represented by a tree. We know too that the Tree of Knowledge was represented on the same astronocal principle by the Oriental nations, and by the Platonists themselves; and this is proved by Egyptian and Mithraic monuments. For instance, they painted it by a Tree with one trunk, with three branches, and seven different kinds of fruit, typifying the Planets, and represented the Fruit of Life by the Sun, and of Death by the Moon. The Rabbins, indeed, express themselves in the same manner in mysticizing on the branches of the Sephyroth. If then we refer this mysticizing theory to the branches of the Pyramidal caverns, we shall find an exact and striking coincidence.

"As to the magnificent passage which leads to the Solar chamber, I should imagine, from the benches which accompany the course of the walls, and their distinct division into something like the stalls of monastic temples, that it was occupied by the assembled College of Priests, who possibly witnessed the efforts and triumphed in the success of the blindfold initiate. The descent of Ulysses and of Orpheus seem both to allude to the latter circumstance; but the curiosity of Orpheus removed the veil.

"But however this may have been, there can be little doubt, that most of the poetical descents into Hell originated in the third passage. The description of it singularly coincides with that of Virgil. There are at the end of the second gallery, three ways, the one leading to Elysium, (the abode of the Sun, according to Bryant,) the other to the abode of Proserpine (the Queen's chamber), and the last to Tartarus, that is to the Catacombs, the only Infera of

the Egyptians. It was here then that three priests were stationed to prevent the intrusion of improper persons, who in the Coptic language were called *Caen*, a word which the Greeks translated *Dogs*, and thence the triple-headed Dog *Cerberus* of the poets. And here, if I may be allowed to speculate on the description of Virgil, that beneath an over-shadowing rock, to the left, the city of Tartarus was placed at the entrance of these ways, I should place the dungeon of the Temple in the grotto beneath; for there is little doubt that the Tartarus of the poets originated in the penances of the Priests, exemplified either in the persons of their refractory satellites, or on those of initiates who had violated their oaths. Hence arose the stories of Sisyphus, Ixion, of the Danaides, victims, as it would appear, condemned to draw water, to raise stones, or to move the wheels of machinery."

Mr. Clarkson then proceeds with an interesting description of Elysium, which he contends was the garden of the Monastic College; detailing rather at large the mystic dramas that were there represented, and ending with a learned and curious argument on the Origin and Effects of Dramatic Representation.

Upon the whole, we take our leave of Mr. C. with considerable feelings of respect. We have derived at once pleasure and information from his lectures, and we sympathize cordially with his future objects.

WERNERIAN NATURAL HISTORY SOCIETY.

At the first winter meeting of this Society, an interesting communication from Dr. Arthur Edmondstone was read, concerning the *Larus parasiticus*, or Arctic Gull. Owing to the remote situation of the haunts of this gull, its history and manners have hitherto been little known. Dr. Edmondstone has now illustrated them. He has observed two kinds of arctic gulls in the Shetland islands; the common sort, with the breast and belly of a mouse colour; and another sort with the breast and belly pure white. Each kind keeps together; and the white is a larger and heavier bird, but less bold than the other. The Doctor is therefore inclined to consider these not merely as varieties, but as distinct species.

At the same meeting, Professor Jameson read to the Society a short description of several varieties of the precious stone named *Zircon*, which he had lately discovered imbedded in sienite, in Galloway. He also informed the Society,

ciety, that he had observed in the same rock in Galloway, both the brown and the yellow subspecies of that very rare ore, known to mineralogists by the name of Rutilite or Sphene.

At the meeting on the 30th of November last, Professor Jameson read a paper on Granite. He described three principal formations of granite, and two of sienite. Two of the granite formations belong to the primitive class; the third to the transition: and of the sienites, one is primitive, and the other transition. He mentioned particularly the appearances that present themselves at the junctions and alternations of the granite and sienite with gneiss and *killas* (which last is probably a newer gneiss), and the relations of these rocks to mica-slate, clay-slate, gray wacke, and gray-wacke slate. The descriptions were illustrated by numerous sections and specimens from Galloway, island of Arran, and other parts of Scotland. The Professor afterwards gave the natural history of a new genus of concamerated fossil shell. In describing this shell, he employed the usual zoological language; but in detailing the other particulars, the method followed was that used in giving the natural history of minerals.

At the same meeting the Secretary read a communication from the Rev. Mr. Fleming of Flisk, containing an account of a bed of fossil shells which occurs on the banks of the Frith of Forth near Borrowstounness. The bed is three feet thick, nearly three miles in extent, and is situated about thirty-three feet above the present level of spring tides. The kinds of shells which compose this extensive bed are still found in a recent state in the Frith.

At the same meeting, also, Mr. Leach gave a description of a new British species of *Echinus*, which he had observed in plenty at Bantry Bay in Ireland, and which he proposed to call *E. lithophagus*, from the circumstance of its forming a small hollow for itself in the substance of the submarine rocks.

At the meeting on the 14th of December, Professor Jameson read a short general account of the geognosy of the stewartry of Kirkcudbright. It would appear from the Professor's description, that the greater portion of this part of Scotland is composed of gray-wacke, gray-wacke slate, and transition slate, with subordinate beds of *transition porphyry*, transition greenstone, and flinty-slate. But three tracts, the first of which contains the mountain of Criffle; the second, Cairnsmuir of Dee, &c.; and the third, Loch Donne, are composed of granite, sienite, sienitic porphyry,

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and killas. The sienite and granite in some places are covered by the killas; in other places the granite and sienite rest upon the killas; and Professor Jameson also observed the killas alternating with beds of granite and sienite, and veins shooting from the granite into the adjacent killas. The granitous rocks, besides felspar, quartz, mica, and hornblende, also contain imbedded rutilite, titanitic iron-ore, and molybdena; and, in rolled masses of a reddish-coloured sienite, crystals and grains of zircon were observed. Professor Jameson also stated several of the characters of the killas, described the magnetic pyrites it contains, noticed its affinity with certain rocks of the transition class, and exhibited specimens to illustrate this affinity.

At the same meeting there was read a series of thermometrical observations on the temperature of the Gulf stream, by Dr. Manson, of New Galloway: and a description of a new craniometer, proposed by Mr. W. E. Leach, illustrated by a sketch.

XXII. *Intelligence and Miscellaneous Articles.*

VACCINATION.

On this subject we have lately seen an address by Edward Rigby, Esq. senior surgeon of the Norfolk and Norwich hospital, to the Corporation of Guardians of the Poor of the city, which presents some facts that cannot be too generally known. This gentleman, while variolous inoculation was the only method known for lessening the ravages of the small-pox, was ever ready, not only to inoculate the poor gratuitously, but omitted no opportunity, either by writing or by conversation, to promote its general adoption; but Providence having placed in our hands means of security against that loathsome disease equally efficacious and much less exceptionable, namely vaccination, Mr. Rigby has been one of its most strenuous advocates, and has exerted himself to root out the small-pox entirely, from Norwich and its neighbourhood.

After stating some of the measures that he had recommended, but which it would appear had not been sufficiently attended to,—he states, that "the small-pox did disappear in the autumn of 1806: it had seized on all the victims within its reach, and, like a fire, ceased to burn only for want of additional fuel; nor did it again visit the city till August 1807, when it was introduced in the following way:—

"On the Monday of the Assize-week in that year, Mr. Robinson,

Robinson, one of your surgeons, called upon me in the morning, to say he had been to visit a poor woman at the Waggon and Horses, in St. Giles's-street, who had just been brought thither from the London waggon, and that she was in the eruptive stage of the small-pox, and he was very anxious that I should advise him how she could be disposed of. I told him, I feared I had now no power either as a magistrate or as a guardian to direct in such a case, as a late resolution of the court had rescinded the orders, under which, heretofore, patients under such circumstances had been sent to the Infirmary; but I wished him to apply to Mr. Simpson, the clerk of the court of guardians, to Mr. Lubbock, the mayor's justice clerk, and to the chief magistrate himself; all which Mr. Robinson took the trouble of doing, but to no purpose—there was no place to which she could be sent, and she was under the necessity of going through this infectious disease at a public-house, in a public street, and at a public time when there was a more than usual number of strangers in the city. The consequences were obvious—a person in the public-house caught the disease, from whom it was communicated to another in the neighbourhood, and thence it gradually spread to the several parts of the city, and continued its ravages among the poor to the end of the year 1809; during which time, no less a number of deaths from this dreadful disease than TWO HUNDRED AND THREE were recorded in the weekly bills of mortality. The greatest fatality was in 1808, in some weeks ten, thirteen, and even fifteen died; and from June 1808 to June 1809 the number of deaths was 171.

I am satisfied that these accounts are correct; and I feel no small gratification in reflecting, that a record so important to humanity would not have existed, had I not, when mayor, directed the keeper of the bills of mortality to notice every death from the small-pox. In a statistical as well as moral view, these facts are highly interesting. I think it likely, as there are few adults in populous places who have not had the small-pox, that this long list of deaths consisted almost entirely of children; and if the common average of deaths from small-pox, as derived from tables kept for a series of years in London, Paris, Vienna, and other large cities in Europe, be correct, and which is one in six, it is evident, that within this period more than twelve hundred individuals must have had the disease; and the probability of these being children is increased, by this number so strikingly corresponding with the number of births in three years in that class of society liable to the disease,

disease, reckoning from the time when the small-pox disappeared at the end of 1806, to the end of 1809, when it again ceased. The annual births in Norwich for the last four years are about nine hundred; somewhat less than half of this number, or four hundred, probably belong to the lowest or unvaccinating class; which in three years will produce by births about the number of individuals who had the disease at this period, and which, as I before observed, must have been somewhat more than twelve hundred *.

"The *moral* reflections which necessarily arise from this melancholy detail need not now be insisted upon. I will however just observe, that had this patient been fortunately sent to the Infirmary at the time Mr. Robinson called upon me, and which was, I believe, before the disease had reached that stage which renders it infectious, she would not have been in a situation to have communicated it; and the city, in that instance at least, would have been spared the dreadful visitation to which so many human lives were sacrificed; and had the former wise regulations of this court remained in force, it is sufficiently clear that she would have been sent thither."

To Mr. Tilloch.

Sir,—In plate xvii. of the 3d vol. of Mr. Parkinson's valuable "Organic Remains," is figured at fig. 2. the impression of an insect, whose species the author professes himself unable to determine. He will probably therefore not be sorry to be informed through your medium, that it is clearly the impression of the larva of a species of Libellula or Dragon Fly; I conjecture, of *L. quadrimaculata*, a figure of which may be seen in the 6th vol. of Remains, tab. xxxvi. fig. 1. and 2. What Mr. Parkinson terms "the sting," is the intermediate one of the three pointed processes found at the anus of many of the tribe, but not at all analogous to a sting. The legs have not been, as Mr. P. supposes, eight, but six, the usual number in insects.

Jan. 27, 1812. I am, sir, &c. &c.

C. E.

* Admitting this conjecture to be well founded, as more than two years have elapsed since the small-pox was in Norwich, it follows, that at this time there are more than eight hundred children liable to catch the disease, should it again find its way into the city. If also it be true, that this disease is fatal to a sixth of the individuals infected, it is equally clear, that unless some efficient means are adopted to secure the lower classes from the infection, an average annual loss to our population of more than sixty persons will be sustained.

To

To Mr. Tilloch.

Sir,—I beg to ask for information of some of your correspondents, respecting the cause of an optical phænomenon, for an explanation of which I have in vain looked in books.

Surveying lately through a compound microscope at a friend's, one of the sliders, I was struck by the figures which I knew to be impressed upon it appearing to my sight to be in relief; and was still more surprised to find, that to my friend, who at my request looked through the microscope, they retained their actual impressed appearance. I then put one of the old penny pieces under the glass, and the letters indented round the margin appeared in relief, while the head seemed as obviously excavated; yet to my friend's eye, as well as to that of a lady present, the natural appearances only presented themselves. I am not aware of any peculiarity in my visual organs, except that of being in a slight degree short-sighted, which does not seem sufficient to account for the difference.

I am, sir, your most obedient servant,

S. P.

NEW PROCESS FOR REFINING SUGAR.

A valuable and simple process has lately been discovered by Edward Howard, Esq. F. R. S. for refining sugar, which promises to be of great advantage. The following is an outline of the process, but a more detailed account of it may be expected to be published by that gentleman himself:—"Take brown sugar, sift it through a coarse sieve, then put it lightly into any conical vessel having holes at the bottom (like a coffee machine). Then mix some brown sugar with white syrup, that is, syrup of refined sugar, to the consistency of batter or thick cream, and pour it gently on the top of the sugar in the vessel till the surface is covered. The syrup will soon begin to percolate, and leave the surface in a state which will allow more syrup to be poured upon it, which is to be done carefully. The treacle will be found to come out at the bottom, having left the whole mass perfectly white. The first droppings are to be kept apart, as the last will serve to begin another operation. The sugar is now in a pure state, except as to its containing insoluble matter, which may of course be separated by solution in water.—The clarification is to be performed by the best pipe-clay and fuller's-earth, and the addition of neutral

neutral alum, if lime be previously contained therein; the whole to be agitated together; and, if expedition be required, it should be heated to the boiling point: the fæculencies will then subside. The brown syrup may also be much improved by means of tannin and the above earths. To make the sugar into snow-white powder, it is only necessary to evaporate the clarified solution to dryness on a water-bath. To make loaves, the common methods may be resorted to, or the syrup drawn off by exhaustion, or small grains may be made according to M. Du Trone's process, *with much water*, and these grains may be cemented by hot concentrated syrup."

Mr. Saumarez will shortly publish a work on the Philosophy of Physiology and of Physics; comprehending an examination of the modern systems of philosophy.

LIST OF PATENTS FOR NEW INVENTIONS.

To Jasper Augustus Kelly, of Kentish Town in the county of Middlesex, engineer and architect, for certain improvements in the construction or formation of arches, and other erections and buildings, which, in respect to the patron of the said invention, they denominate "Moore's modern Architecture."—15th Jan. 1812.

To John Taylor the younger, of Chesterfield in the county of Derby, gentleman, for a machine and rods for cutting, spreading, and preparing wicks for dip candles.—20th Jan.

To John Raffield, of Edward-street, Cavendish Square, in the county of Middlesex, architect, for an apparatus to be attached to fire stoves, of all descriptions, for rooms, for the removal of cinders and ashes, and the better preventing of dust arising therefrom.—20th Jan.

To Jacob Zink, of Glove Road, Mile End, in the county of Middlesex, chemist, for a new method of manufacturing verdigris, which he denominates British verdigris.—20th Jan.

To George White, of Worthing in the county of Sussex, smith and ironmonger, for a new or improved method of preventing accidents from carriages.—20th Jan.

To Andrew Patten, of Hulme, in the parish of Manchester, in the county of Lancaster, iron lignar manufacturer; and Charles Hankinson, of Hale, in the parish of Bowden, in the county of Chester, tanner, for their improvement in the

the tanning of leather by the use of pyrolignus or wood acid. —20th Jan.

To George Dodd, of Vauxhall Place, in the county of Surry, engineer, for certain machinery and the application of steam to communicate heat and motion to wines, porter, and other liquids or fluids, in cellars, storehouses, warehouses, or other places.—23d Jan.

To John Beale, of Chad's Row, in the parish of St. Pancras and county of Middlesex, mathematical instrument and umbrella maker, a for machine or engine for cutting of trunnels and spiles, and various other articles.—23d Jan.

To William Onions, of Paulton, in the county of Somerset, engineer, for a new engine or machine which may be wrought by steam or other power.—23d Jan.

To Richard Rowland, of the city of Bristol, mathematical instrument maker, for certain improvements in ships' steering wheels, compasses, and binnacles, and in the mode of lighting the same with lamp or candle, by which same light the cabin or other part of the vessel may be lighted; likewise a method of preserving the candles in hot climates.—23d Jan.

To George Babb, of Bordesley, near Birmingham, in the county of Warwick, engineer, for a new method or principle of producing files, plane-irons, fire-irons, and other articles.—23d Jan.

To John Brown, of Mile End New Town, in the county of Middlesex, stationer, for a pocket on an improved construction to be used about the person or otherwise.—25th January.

Meteorological Observations made at Clapton in Hackney, from Jan. 21, to Feb. 20, 1812.

Jan. 21.—Fair day, *cirri* and others. N.

Jan. 22.—Clouded and hazy day. N.N.W.

Jan. 23.—Lofty and ill-defined cumulative masses of cloud. N.E.

Jan. 24.—Lofty cumulative clouds like yesterday: a coloured phænomenon was described as having been seen at Walthamstow, this evening, about the moon, which from description appears to have been what I have called the *halo discoides*.

Jan. 25.—Calm foggy day, with westerly wind.

Jan. 26.—Hazy morning; evening fair, though a strong mist prevailed. W.

Jan. 27.—Cloudy and hazy morning; windy night; a lunar

lunar *corona,* somewhat coloured, appeared about seven o'clock; about ten a *halo* of the usual size*. S.W.

Jan. 28.—Clouds and wind from the S.S.W.

Jan. 29.—Before sunrise lofty *cirri* appeared highly coloured, which kind of lofty and confused *cirrus* prevailed all the morning, with large spreading sheets of *cirrostratus,* followed in the evening by wind and rain. S.W.

Jan. 30.—Hazy morning, followed by clear day and evening showers. S.W.

Jan. 31.—Cloudy, calm, hazy day. S.S.W.

Feb. 1.—Much cloud all day with haziness. S.

Feb. 2.—Fair morning; various *cirrocumuli* and *cumuli,* followed by high wind, with some rain by night. S.W.

Feb. 3.—Fair morning, with lofty cumulative clouds: dark rainy evening. S.W.

Feb. 4.—Hazy, with some small rain. S.W.

Feb. 5.—Misty, followed by a warm rainy day. S.

Feb. 6.—Dull, clouded, unpleasant day.

Feb. 7.—Fine clear morning and W. wind, with flimsy *cirri* and *cirrocumuli* followed by much cloud, increased temperature, and rain at night, with a gale from S.W.

Feb. 8.—Fair morning with various clouds followed by a rainy evening. N.E.

Feb. 9.—Much cloud, in the evening a general obscurity prevailed. W. and N.W.

Feb. 10.—Fine day; much *cirrus* spread about aloft, in a lower region massy and spreading *cumulus;* clear night. S. and S.E.

Feb. 11.—Clear morning and frosty, afterwards the clouds assumed the cirrocumulative aggregation, and were followed by increased temperature, and a clouded night.

* The ancient writers seem to have been well acquainted with these phænomena, but they did not well distinguish the *halo* from the *corona.*

"Existunt eædem coronæ circa Lunam, et circa nobilia astra cœlo quoque inhærentia. Circa Solem arcus apparuit L. Opimio Q. Fabio Coss. Orbis L. Portio M. Acilio."—*Plin. Hist. Nat.* lib. ii. cap. 29.

"Circulus rubri coloris L. Julio P. Rutilio Coss."—*Cap.* 30.

The parhelion and paraselene were also noticed by Pliny.

"Et rursus plures soles simul cernuntur, nec supra ipsum nec infra, sed ex obliquò, numquam juxta semel et meridie conspecti in Bosphoro producuntur, qui a matutino tempore duraverunt in occasum."—*Cap.* 31.

"Lunæ quoque trinæ Cn. Domitio C. Fannio Consulibus apparuêre, quas plerique appellaverunt soles nocturnos."—*Cap.* 32.

Aristotle's descriptions appear more accurate than Pliny's.

"Περι δε αλω και ιριδος, τι θ' εκατερον και δια τιν' αιτιαν γιγνεται λέγωμεν, και περι παρηλιων και ῥαβδων," &c.—*Arist. Meteor.* lib. iii. cap. 2.

By ῥαβδοι I understand *radii;* and I suppose the author to have meant some such phænomenon as is described by Virgil as a prognostic of bad weather:

> "Aut ubi sub lucem densa inter nubila sese
> Diversi erumpunt radii," &c.—*Georg.* lib. i. 445.

Feb.

Feb. 12.—Overcast and hazy day; towards night the wind rose and became high with some small rain.

Feb. 13.—Fine clear morning, with *cirrocumulus* and *cirrus*, while *cumuli* sailed along lower down: afterwards *cumulostratus* continued to form through the day; but the night became clear, and the stars shone bright. I observed a very small meteor about eleven o'clock. W.

Feb. 14.—Rain set in early, and its streams continued to increase in size and strength all the morning, with rising wind; in the afternoon it cleared, but the wind continued high, and got from S.W. to N.W. The phænomenon of the old moon in the new moon's horns, as it is called, was very clearly conspicuous this evening. Some common kind of small meteors by night.

Feb. 15.—Fine morning; very high up much spreading *cirrus* passed on gently from N.N.W. breaking out into various forms, in some places giving the idea of fine granulations; in others arranged in beautiful rows of spots, approaching to *cirrocumulus*, or stretched along in tufts, its fibres verging in different directions: lower down loose flimsy *cirrocumulus*; and still lower, masses of *cumulus* and what sailors call *scud* floated rapidly along in the west wind: by and by *cumulostratus* formed by inosculation, as it seemed, and obscured the sky.

Feb. 16.—Features of confused *cirrus* appeared aloft; *cumulus* lower; afterwards *cumulostratus*, and general obscurity: rain at night. W.

Feb. 17.—*Cirrus*, &c. followed by wind and rain in the morning; afterwards showers and clear intervals; at night very cloudy with rain and very boisterous wind. W.

Feb. 18.—Misty overcast morning, and fair day. N.W.

Feb. 19.—Misty, overcast and windy; clear night with a few light clouds. S.W. and S.

Feb. 20.—Clear morning with much *linear cirrus* extending north and south; afterwards various *cirrus* and *cirrocumulus* in different altitudes. At night a *corona** round the moon was sometimes double and coloured, at others single and of various sizes, according to varieties in the intervening cloud.

Five Houses, Clapton, Feb. 21, 1812. THOMAS FORSTER.

* At times the *corona* appeared almost *triple*. I have said in my paper on *Halones*, that a triple *corona* was seldom seen. I have, however, since writing that, seen several.

METEORO-

METEOROLOGICAL TABLE,

By Mr. Cary, of the Strand,

For February 1812.

Days of Month.	Thermometer. 8 o'Clock, Morning.	Noon.	11 o'Clock, Night.	Height of the Barom. Inches.	Degrees of Dryness by Leslie's Hygrometer.	Weather.
Jan. 27	43	47°	46°	29·92	12	Cloudy
28	45	48	40	·60	17	Cloudy
29	36	47	41	·12	0	Stormy
30	42	48	37	·22	12	Fair
31	36	46	47	·78	13	Fair
Feb. 1	46	47	46	·59	0	Small rain
2	45	47	42	·52	0	Rain
3	42	48	46	·42	4	Cloudy
4	47	47	47	·77	7	Cloudy
5	47	47	46	·45	0	Rain
6	46	46	42	·62	0	Cloudy
7	34	47	40	·52	6	Fair
8	38	48	40	·75	0	Rain
9	42	43	40	·92	0	Foggy
10	40	46	33	·82	10	Fair
11	32	46	40	·72	25	Fair
12	40	50	42	·36	0	Showery
13	40	46	33	·56	21	Fair
14	40	48	41	·30	0	Stormy
15	40	47	43	·60	10	Showery
16	42	50	48	·63	30	Cloudy
17	50	52	43	·33	0	Stormy
18	43	53	40	·90	28	Fair
19	45	54	43	30·03	27	Cloudy
20	38	56	47	29·90	30	Fair
21	47	56	46	·67	28	Cloudy
22	46	55	43	·46	0	Storms with
23	44	52	40	·45	40	Fair [thunder
24	33	43	33	·62	18	Fair
25	40	44	35	·38	0	Rain
26	32	42	33	·56	25	Fair

N. B. The Barometer's height is taken at one o'clock.

ERRATA in our last Number.

Page 8, line 15, for 23° read 13°. Page 16, line 43, for 0′ read 12′. Page 18, line 26, for ·0011 read ·011.

XXIII. *Description of a Cavern near Chudleigh in Devonshire. By Mr.* J. Jones, *of Pembroke College, Cambridge. Communicated by the Author.*

The Devonshire marbles have been lately much in request for ornamental purposes; and since it has been found impossible to obtain the more costly marbles of Italy, the attention of our artists has been directed toward the produce of our own soil. The strata of limestone or marble traverse the country in various directions, adding considerably to the beauty of the scenery; for at some places they sink beneath the surface of the earth, and at others rise with majestic grandeur to a nearly perpendicular height of two or three hundred feet, presenting from their summits views not to be exceeded for extent or picturesque effect by any in the kingdom; and what adds considerably to their appearance is, that their tops are not barren, but ornamented with mountain plants and a lively verdure, and their sides are rendered shaggy by the shrubs and trees which grow in abundance from their crevices. These hills are particularly interesting to the traveller, and may not prove uninstructive to the geologist; for caverns of considerable magnitude have been discovered within their bowels, in which a profusion of stalactitical and stalagmitical depositions abounds. The most celebrated of these caverns are Kent's Hole in the vicinity of Torquay, and the Piscies'-hole in Chudleigh rock near the town of Chudleigh: the first I have never seen, but have frequently visited the latter.

The Pixies' or Piskies' Hole, as it is commonly called, being the supposed habitation of a diminutive race of fairies, is situated in part of the rock which faces the woods of Ugbrook Park, the seat of Lord Clifford: the ascent is rather difficult, being narrow and winding; but after having ascended for a short time, the entrance presents itself almost concealed by trees and shrubs: the entrance is 10½ feet in breadth, and 9 feet in height, and the same dimensions are nearly preserved for 67½ feet after you enter the cavern: it then suddenly diminishes into a narrow hole not exceeding 3 feet in height and 7 feet in breadth: before you enter this narrow passage you are necessitated to descend on your hands and knees, and light your candles, for without light it is impossible to explore the interior of the cavern: this narrow passage is the greatest difficulty to be encountered; but it is not of any considerable length, not exceeding 57 feet: at its extremity you suddenly emerge

into a large and magnificent cavity, formed within the bowels of the rock, of considerable magnitude, and not cheered by a single ray of light from above: huge pieces of rock which must have fallen from the top impede your progress, and considerable caution must be observed in passing over these fragments. The length of this cavity is 39 feet; its greatest height about 50 feet, and breadth 12 feet; it terminates in a narrow cleft, too small to admit a middle-sized man: the silence of this cave is never disturbed, except by the bats which are observed to be suspended from the top; and the sound produced by the labourers from without, blasting the rock, reverberates through the hollows like thunder. A great number of stalactites depend from the top, assuming various forms; but they are not remarkable either for whiteness, or beauty of appearance. The rock consisting entirely of limestone, of course all the depositions are calcareous: one deposit demands particular attention, as it is considered the guardian idol of the cavern: it is situated on the left hand as you enter, a few feet from the bottom, and presents the appearance of a human head; it is commonly called the Pope's head. The reason of this appellation it would be perhaps now difficult to discover: owing to the continual droppings from above, its surface is soft, and all visitors are desired by the guide to stick a pin into the head, to serve as a defence against the machinations of the fairies. From this principal cavity another branches off of greater regularity and of a more vaulted appearance: this second passage is 9 feet in breadth, 11 feet in height, and 72 feet in length; it is called the Pixies' parlour, and the bottom is sufficiently level to admit of dancing. Here fires are lighted, and parties regale themselves: the effect is awful and striking, the flames playing about the cavern, the sound of the music, and the resounding echos of the voices. Banditti might have chosen this as a proper place to have held their revels. At the extremity of this cavity the light is seen streaming through the rock from above, and on looking up you perceive a narrow opening of considerable height; at the top of which huge masses of rock seem suspended over your head, and strike the mind of the spectators with terror lest they should suddenly be crushed to pieces. This was certainly the first opening by which the cavern was entered, and the narrow passage was afterwards effected by the hand of man: its regularity forbids the idea of its natural origin.

Besides the abovementioned chambers, several narrow entrances are discovered, which may perhaps lead to the discovery

discovery of other cavities equal to those already explored. But the foot of man has never yet passed into those concealed caves; and the traditions of the vulgar respecting them are of the most fearful kind: unfathomable depths of water, with all accompanying horrors, are predominant *. That water may sometimes be collected in those cavities, may not be improbable; yet I have thrown down several stones, and water was never heard, and the stones soon reached their termination. One tradition is worthy of being remembered: a dog was once thrown into one of those pits, and some weeks after it emerged at Botter rock near Heniock, a village about four miles from Chudleigh; and the most remarkable part of the tale is, that all its hair was rubbed off: this is a degree of consistency not often to be observed in popular tradition.

Having finished the description of the cavern, I shall now hazard a few remarks respecting the use to which it was applied by the Aborigines of Damnonium. Caves were certainly the first habitations of the wandering tribes, and perhaps first suggested the idea of constructing more convenient places of abode. Some savages are now found ignorant of the means of constructing any settled habitation, and who retire to the crevices of the rocks as a defence against the inclemency of the weather †. The Eastern nations seem to have been more particularly attached to subterranean abodes. The deeds of Jesus Christ are said by the inhabitants of Palestine to have been performed in caves ‡. Xenophon particularly describes the caves of the Armenians §; and the temples of the Hindoos are frequently placed in excavations at first formed by nature, and afterwards improved by art: such is the singular cave in the Isle of Elephante, and the caves of Carli and Kenneri ||. By the Orientals, caves were used as places of abode, as retreats in case of defeat from the enemy, and as temples for the celebration of religious rites. The first colonists of Damnonium proceeded from the East. This hypothesis was first stated by Sir George Yonge, and supported by Polwhele in his excellent historical Views of Devonshire. Major Welford has more recently conjectured, that the sacred Isles of the Hindoos were situated in the Western Ocean.

* Risdon in his Chorographical Survey of Devon, in page 332, last edit. when speaking of Chudleigh, says: "There is a cave hereabouts that creepeth far under the ground, of which many marvellous matters are spoken."

† See Collins's Account of New South Wales.

‡ See Harmer's Observations, and Maundrell's Travels.

§ *De Expeditione Cyri*, lib. 4.

|| Asiatic Researches, vol. ii. and Valentia's Travels, vol. ii.

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We cannot for a moment suppose that people capable of undertaking long and tedious voyages were ignorant of the means of constructing houses; yet the caves might attract their attention either in a military or religious point of view. The Pixies' Hole was undoubtedly known to the earlier inhabitants of Damnonium. Art has been used in forming the narrow passage; but it presents no appearance of having been diminished in size. The first entrance to the cavern was effected through the cavity I have before described, as descending from the side of the rock. When the interior was gained, a more commodious outlet was desirable; the narrow passage was then formed, of small extent, by which means all hostile attacks were prevented. It is impossible to account for the sudden diminution of the first entrance, and the regularity of the second passage, by any other conjecture.

However convenient the Pixies' Hole might have been as a place of retreat during the time of hostile invasion, it never seems to have been used for a religious purpose. Yet its awful shades and lengthened caverns, the venerable rocks and wood by which it is surrounded, would have admirably accorded with the superstition of the Druids: but after the most laborious search I have not yet been able to discover any Druidical antiquities in the immediate vicinity of Chudleigh, notwithstanding the numerous tumuli still to be observed on the hills of Halldown, distant but a few miles, afford convincing proof of a once numerous population; although the absence of Druidical remains tends to remove all conjectures respecting the religious use of the cavern. I am unwilling to suppose that it passed unnoticed by the Druids. The singular stalactitical deposit called the Pope's Head may, without any inconsistency, be named the Deity of the cavern; and the superstitious usages of former ages have not yet entirely vanished, as respect is paid to its singular and striking form. I have but one more remark to offer, and that respecting the origin of Gothic architecture. It has been confidently asserted, that groves of trees first suggested the Gothic arch, nave, and transept of our ancient cathedrals*. But it seems more probable that the vaulted roof and stalactitic pillars observed in caverns first gave the idea. Religious rites were at first performed in caves; and when removed to groves and buildings, the priests and people endeavoured to retain the form of these ancient natural temples, from whence arose the solemn and massive grandeur of Gothic architecture.

February 29, 1812.

* See Warburton's Notes on Pope.

XXIV. *On*

XXIV. *On the different Qualities of Wines, and the Methods of preserving and ameliorating them.* *By M.* Duportal, *M.D.* *.

In my preceding Dissertation † on Fermentation, I took particular care to describe that species of it which furnishes, as its product, an intoxicating liquor, and is especially employed in procuring this liquor from the grape. This constitutes *wine*, so agreeable a beverage to mankind in general, and in which the constituent principles are the most intimately combined. In all times, therefore, this useful and pleasing liquor has occupied the attention as well of the chemists as of the makers of wine. Among the former, M. Chaptal appears to me to have thrown the most light upon the subject of wine. Whoever attentively reads what this learned chemist has written upon the causes which influence the quality of wine, the means made use of to preserve and ameliorate it, the vessels proper to keep it in, and upon the changes and degeneration of which it is susceptible, cannot fail of assenting to the theory, by which he accounts for a multitude of facts and numerous circumstances which have hitherto been considered inexplicable. A detail of all he has written upon this subject, although in itself very important, is adapted rather to a treatise of agriculture than for a chemical journal; I shall therefore confine myself to those parts of his writings which relate directly to the general chemical theory of the preparation of wine.

1. *Of the Causes which influence the Quality of Wines.*

The vine at the present day grows almost every where, but particularly between the 35th and 52d degrees of latitude. The wine furnished by it, is not however the same in all countries. This liquor, in general, is only good in countries between the 40th and 50th degrees. Considerable difference also exists within these latitudes, whence are produced an infinite variety of wines, which cannot be confounded with each other, notwithstanding the chemical composition of all of them is pretty nearly the same.

Among the causes which have an influence upon the quality of wines, M. Chaptal enumerates:

1. The different species of the cultivated vines.
2. The variety of climates where they grow.

* *Annales de Chimie*, 1811.

† See Phil. Mag. vol. xxxviii. pages 221 and 246.

3. The

3. The different nature of the soils.
4. Their more or less favourable exposure to the sun.
5. The seasons being more or less propitious.
6. The culture being more or less attended to.

There can be no doubt, but that all these causes produce considerable influence upon the nature of the grape, which in its turn influences the product of the vinous fermentation. But the manner in which this operation is conducted, contributes also to impart to the wine certain qualities which render it more or less esteemed. Of this I treated in the former memoir, and proceed now to the method of preserving the wine, after it has been poured into the cask.

2. *Of the Methods employed for preserving and ameliorating Wines.*

The juice of the grape being converted into a vinous liquor by fermentation in the vat is put into casks, where it undergoes a new elaboration, which renders the liquor turbid, and reproduces in it a slight tumultuous motion, which is called the insensible or secondary fermentation. This intestine motion is to be encouraged or moderated, according as the wine drawn from the vat contains an excess of sugar or of ferment. In the first case, if we do not wish to have a sweet wine, it will be requisite to permit the insensible fermentation to go on, in order to convert the sugar into alcohol, whereby the wine will become stronger; in the second case, on the contrary, the insensible fermentation should be speedily stopped, lest the wine should be converted into vinegar. This is to be effected either by removing the sediment and scum, and clarifying the liquor, so as to extract all the ferment it contains, or by adding to the liquor some sugar, for the fermentation to act upon, which will give a degree of strength to the wine which it would not have possessed without this management. While the secondary fermentation is going on in the cask, there is disengaged a great quantity of carbonic acid gas, and there runs over from the bunghole a considerable quantity of scum, which renders it necessary to add more wine; and this operation must be repeated until the fermentation has entirely ceased. The cask is then generally bunged up with care, and no further thought taken of the wine until it is fit for use. The liquor, when left at rest, very soon throws down all that is not completely dissolved in it, and even a portion of the tartar, whence results a sediment, known under the name of *lees* or *fæces*, which is usually separated from the wine; for this sediment acts upon it in the

the nature of a ferment, especially when assisted by agitation, change of temperature, and other causes. In this case, as also when it is necessary to take away the fermentescible substances, the wine undergoes certain manipulations, reduced by M. Chaptal to three,—racking, brimstoning, and fining.

Racking of Wines.—The racking of wine is performed by drawing it into another cask, defecating it, and leaving behind the lees, a matter consisting in general of ferment, altered by the fermentation of the must, some ferment unaltered by the operation, mucilage, tartar, and colouring matter. The lees, however, are not always the same from every kind of wine; the quantity of tartar varies, as also that of the colouring matter, according as the wine is more or less spirituous; in different wines there is more or less of the ferment, and this has undergone more alteration in some wines than in others. Thus a sweet Spanish wine does not contain any unchanged ferment, because the sugar in it is more than sufficient to decompose the whole of this substance; by adding more ferment to this wine, you will diminish its sweetness, and increase the alcohol. On the contrary, a meagre wine of Burgundy will afford a great quantity of unaltered ferment, because the deficiency of sugar did not permit the whole of it to be decomposed. By the addition of sugar to this wine, the fermentation would be renewed, and more alcohol produced. The racking of wines is a necessary operation for the proper keeping of them. In general, this operation should be renewed whenever there is a considerable sediment at the bottom of the cask. Some wines, however, may be kept upon their lees, such as those of St. Thierry in Champagne; these will continue to improve, if kept upon their lees for four years, provided they are contained in casks of a very large size. If we consider the different nature of different wines, and of their lees, we shall easily perceive that racking is not equally necessary for all of them. If, for instance, it is a very weak wine, it cannot be racked off too soon, for the small quantity of alcohol contained in it will not be able to prevent the acetic fermentation taking place, from the action of the ferment in the lees. But if it is a very generous wine, early racking is not necessary, because the great proportion of alcohol renders the ferment of no effect. Moreover, a sweet and syrupy wine will become improved by keeping on the lees, because the sugar contained in it will be acted upon by the fermentescible principle of the lees. Even a very tart wine, when kept upon its sediment

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will grow better, when its tartness is owing to a too slow and incomplete fermentation, in which the sugar has not been entirely converted into alcohol. M. Chaptal, in the following passage, clearly establishes the truth of this assertion. "We must only, says he, draw off those wines which have been well made: if a wine is very tart, or very sweet, we must let it undergo a second fermentation upon its lees, and not draw it off until the middle of May; it may even stand until the end of June, if it continues tart. It sometimes becomes necessary to return wine upon its lees, and to mix them well together, that a new fermentation may be excited, which will ameliorate the wine." There are certain rules to be observed in the racking of wines; it should never be done in frosty seasons, nor when a moist wind blows; a dry cool wind is preferable; it is most advantageously done, just previous to the periods of the shooting of the vine, its coming into blossom, and the turn of the grape; for it is at these periods the wine ferments most. In every wine country, experience has demonstrated the proper time for this operation.

Brimstoning of Wines.—Whatever care is taken in the racking of wines, they will again ferment, unless they undergo the operation of brimstoning; that is to say, if they are not impregnated with sulphurous gas, by means of burning sulphur matches in the casks, either when completely empty, or containing a few pails full of wine only, to which more wine is added every time the burning is renewed. At Marseilles in Languedoc, they use for the brimstoning wines, *must*, which has been so strongly charged with sulphurous gas, as never to have fermented; two or three bottles of which, mixed with each cask of wine will also preserve that from fermentation. The brimstoning by burning matches has one disadvantage, that of depriving the must of the flavour of the fruit, and communicating to it an unpleasant taste. On this account, other anti-fermentescible substances are sometimes employed. Thus, M. Perpere recommends sulphuric acid; M. Astier employs the red oxide of mercury; and M. Parmentier has proposed the oxide of manganese, which is less hazardous.

What is the chemical action produced upon the must and upon the wine, by the operation of brimstoning? This action tends evidently to preserve these fluids from fermentation, and as this cannot take place without the presence of a ferment, we have reason to conclude, that this agent is changed in its nature, and rendered insoluble, perhaps because it abstracts from the oxides and acids employed, a portion

portion of their oxygen. We must however acknowledge, that the supposed abstraction of this principle is not essentially necessary, since this fermentation may be prevented by adding some boiling hot wine to the liquor, as is practiced at Paris, which shows that the ferment undergoes an alteration by the action of caloric. Nevertheless, it is certain, that this substance undergoes a change in its nature by the brimstoning, and is rendered in part insoluble, for the wine becomes turbid by this operation: it also sensibly loses its colour, but this is temporary, for it regains its former colour in a few days. M. Chaptal thinks it advantageous to the keeping wines, to preserve them from the atmospheric air, whose contact is necessary to induce the acid degeneration.

Fining of Wines.—The two former operations are not always sufficient to impart to the wine that fine limpidity which is so agreeable to the organs of taste and smell, and which so much enhances its value. There still remain in these liquors certain heterogeneous substances which disturb the transparency of them, and which do not fall down by simple rest. In this case, we must have recourse to a third operation called fining, which is generally performed by fish glue, previously softened into a viscid fluid by maceration in a little of the wine. By this the substances which rendered the wine turbid are carried to the bottom, for we find the wine becomes more limpid, and a sediment is formed, which renders a fresh racking necessary, some time after this substance has been poured into the wine, and well mixed with it. The same effect is produced in the turbid wine by means of ox-blood and the white of eggs. These latter, therefore, may be used to clarify wines, especially the last; which does not so easily undergo a septic change, and is therefore preferable in hot climates, and in the summer season. M. Chaptal affirms that gum arabic may be substituted for these gelatinous and albuminous substances. He even adds, that wine rendered turbid by the lees, may by cleared by a multitude of substances, such as coarse salt, flints calcined and bruised, starch, rice, milk, &c.; likewise by beech chips, first barked, then boiled in water, and dried in the sun, or in an oven. He attributes the effect of the beech chips upon turbid wines to a slight fermentation which they induce in the liquor; we may also refer the action of starch, rice, and milk, to the same circumstance; whilst the action of the greatest part of other substances is purely mechanical. But how

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is the action of the fish glue, the ox blood, and the white of egg to be explained? So little attention has hitherto been paid to what takes place in this case, that I know of no theory formed upon the subject. It appears to me very easy to invent a very plausible one, by attending to the facts I am about to state.

1. Fish glue is a gelatinous matter; the white of egg and the ox-blood are of an albuminous nature.

2. Both of these animal compounds are very soluble in water, and not at all soluble in alcohol.

3. Alcohol exists already formed in wine, since it is easy to separate it by congelation.

These being inconstestible facts, what must happen when these gelatinous fluids are poured into the wine? The alcohol of the wine, by its great affinity to water, will attract this fluid, holding the animal matter in solution, consequently this matter, thus deprived of its solvent, must give way to the molecular attraction, which tends to bring its particles together, whence results a kind of net-work swimming in the liquor; this net-work, contracting more closely, entangles in itself the foreign substances in the wine, and carries them down to the bottom of the cask, leaving the mass of liquor clear, pure, and transparent.

The last method of preserving and ameliorating wines consists in the art of mixing them together, so as to render them less alterable, and to impart to them the most agreeable flavour. This art, although perfectly well known to the manager of a cellar, is not yet known by the chemist, and will never be known by him, unless the wine merchant will inform him what mixtures succeed the best. The experience of this latter would, however, be rendered more advantageous if assisted by the reasonings of the former. A wine mixed with some other wine, can acquire more strength, more colour, more aroma, or more flavour, only by its principles undergoing some reaction, more or less sensible; and who, except the chemist, can best dispose the circumstances most favourable to this re-action? If, for example, it is required to correct a very acid wine; the chemist finding in this wine a great deal of tartar, will propose the addition of sugar, because this substance, by increasing the proportion of alcohol, will precipitate the tartar, and by this means he will avoid having recourse to the sweet and syrupy for that purpose, which are not to be found in all countries, and whose price is always every where so very high.

3. *Of*

3. *Of the Vessels proper to keep Wines.*

After wines have undergone the operations I have above described, it becomes an important consideration in what vessels and in what places they are kept. According to M. Chaptal, a cellar should be dug several feet below the surface of the earth; the openings into which should be towards the north; it should be at a considerable distance from any street, highway, work-shop, sewer, privy, &c. and it should be covered with an arched roof. The ancients preserved their wine in earthen vessels, varnished, such as the amphora and the cadus. The porosity of these vessels has occasioned their being laid aside, and for them have been substituted those made of the wood of oak or mulberry-tree, or, sometimes, glass vessels. The last have the advantage of not containing any principle soluble in the wine, and of preserving the liquor completely from the contact of air and moisture, when carefully stopped; but their brittleness and diminutive size limits the use of them to a very small extent, and it becomes necessary to have recourse to vessels made of dry and well seasoned wood; for if the wood is green, it imparts an extractive matter to the wine, which injures its flavour, and acts upon it in a similar manner to the lees.

M. Chaptal justly observes, that very large and well closed vessels are the best for keeping wine, since it is found that wine is always better the larger the cask; the reason of which, no doubt, is that the constituent principles are more intimately mixed, and do not so easily escape into the atmosphere. This last circumstance is well known to wine merchants, who find, that twenty muids of wine, contained in one large vessel, do not lose more by volatilization in a given time, than two muids do when distributed into four casks.

4. *Of the Deterioration or Degeneration of Wines.*

The greatest care bestowed upon wines will not always prevent their suffering some alteration; they will generally undergo some change if the principles which compose them are not in suitable proportions. M. Chaptal has shown this in his investigation of the deterioration to which wines are subject; a deterioration which, for the most part, he ascribes to an excess of ferment in them. I shall say a word or two of this kind alteration.

Of the Ropiness of Wines.—This degeneration only takes place in very weak wines, and those which have been badly fermented;

fermented; it is known by a ropy, milky, whitish sediment, and the wine then presents a kind of oily appearance. No particular management is requisite to cure this; it is generally sufficient to leave the wine to itself during a season or two, when for the most part, the wine recovers. Exposure in a warm place, or the addition of some sugary substance, will hasten the cure; the same thing will happen if the ropy wine is mixed with some good wine newly made.

The fermentescible principle appears to be the source of this degeneration; from its not having been completely decomposed during the fermentation, a great deal of it is dissolved in the vinous liquor, after the entire decomposition of the sugar. And as this principle may be afterwards separated from the liquor by a variety of causes, M. Chaptal imagines, that it is this separation which gives that oily appearance to the wine I have been describing.

Of the spontaneous Acescency of Wines.—This takes place most frequently in very weak wines, especially at three particular periods of the year, when these liquors are in the greatest state of fermentation, viz. when the vine is budding, at the time of its blossoming, and at the time of vintage. It is, therefore, to the presence of the ferment this deterioration is owing, especially when its action is assisted by air and heat. I have already said, that this action sometimes proceeds so far as to induce the acetous fermentation. The prevention of this fermentation demands the most particular attention, and therefore, all the causes which give rise to it are to be carefully avoided. Unfortunately our efforts are not always successful, and we can only arrest the fermentation, or neutralize the acid. For the former purpose, M. Chaptal recommends evaporated must, honey, or liquorice, to be dissolved in the tart wine. These not only correct the sour taste by replacing it with sweetness, but also reproduce the spirituous fermentation by supplying the saccharine principle for the remaining ferment to act upon. The wine merchants possess a multitude of receipts for neutralizing the acid in wines; they are chiefly composed of salifiable bases, such as potass, lime, and even litharge. These methods, however, but imperfectly answer the purpose, and some of them are attended with no little danger.

3. *Of a fusty Taste in Wines.*

This arises from two causes; the first is, when the wine is kept in a cask made of decayed or worm-eaten wood; the

the other, when the lees of wine have remained in the cask, although they are emptied out at the time of tunning. Willermoz proposes to correct or destroy this taste by means of lime, carbonic acid gas, and oxy-muriatic gas. Others advise the wine to be fined and racked off with care, and then to be infused two or three days upon toasted grains of wheat. In Burgundy, they pour the fusty wine upon the lees of well-tasted wine, and afterwards fine it.

4. *Of Bitterness in Wines.*

Some wines, especially those of Burgundy, acquire by age a taste of bitterness. This is owing to the total precipitation of the ferment, and the complete decomposition of the sugar, which set at liberty the acerb or astringent principle contained in these liquors. M. Chaptal recommends these wines to be re-poured upon the lees, and that there should be added to them a solution of sugar, or what is still better, a pint of musted wine to every cask.

In addition to these alterations already pointed out, wines are susceptible of several others, such as a mouldy taste, loss of colour, rancidity, &c. I cannot now enter upon these, I will only mention that the rancid taste in wines is owing to the precipitation of the tartar and the formation of a small quantity of acetic ether, at the expense of the alcohol and acetic acid contained in the wine, as has been shown by M. Vauquelin.

XXV. *An Apparatus for preventing the Accumulation of Air in Conduit Pipes, &c. &c. By* JOSEPH STEEVENS, *Esq.*

To Mr. Tilloch.

SIR, IT having been objected by many, that the mode proposed for supplying the Sea-water Baths and Infirmary (intended to be established in the vicinity of London), by means of iron pipes from Southend, would be ineffectual, on account of the quantity of air that would accumulate at certain elevated points, over which the pipes will pass. I beg to lay before those persons and the public, through the medium of your publication, the following simple apparatus, which I intend to attach to the pipes for this purpose.

I am, sir,

Your most obedient humble servant,

No. 2, Tower Royal, Feb. 29, 1812. JOSEPH STEEVENS.

AB (Pl. IV.) is a portion of an iron pipe for conducting water; *c* is a tube of about two inches diameter, and six inches

inches long, projecting from the upper part of it; into this tube is screwed the globular vessel *gg* about ten inches diameter, and into this globe is screwed the tube *t*, about one inch external diameter, having a conical opening through it a quarter of an inch on the inside, and half an inch on the outside end of it. In the globe *gg* is the globular float F, about seven, eight or nine inches diameter, as circumstances may require. This globe carries two spindles or rods, the one projecting downwards about half an inch diameter carrying the valve *o*, and the other projecting upwards about ·2 inch carrying the valve *i*; this passes through a guide *nn*, as does the lower rod through the guide *mm*; the part of the lower rod that passes through the guide is flat, to prevent it from turning round in the operation of screwing the float F to it. The tube *t* is provided with a valve *v*, and weight *w*, nearly equal to the weight of the valve.

Things being thus disposed, let us suppose water to flow into the pipe AB until it rises to *pp*, then one half of the diameter Q*q*, will be occupied by air *q r*, and therefore only one half of the water which the pipe is capable of conveying would be allowed to pass: but as there is no water in the globe *gg*, the float F will rest on the guide *mm* and the valve *i* be opened through which the air will escape until F is floated by the rising of the water in *gg*, when the valve *i* will be shut, and none of the water suffered to escape; this operation will be repeated as often as a quantity of air sufficient to fill *gg*, is collected.

The valve *v* is attached in order to prevent any air from entering the pipe, by the tendency of the water to retire in case a partial interruption in the supply should take place; or in the event of a pipe bursting at a point below that to which this apparatus is affixed.

In the tube *c* are two flanches, *h* and *e*; the flanch *h* is intended to prevent the valve *o*, and its rod from falling into the pipe, and would in many instances (though not in the present) supersede the necessity of the valve *v*; the upper flanch *e* is to receive the valve *o*, and prevent the escape of water, should it be necessary to remove the globe *gg*, or the tube *t*, for the purpose of repair, &c.

It is easy to see, that by unscrewing the tube *t*, the float F would rise and close the valve *o*, the same effect would be produced by unscrewing the globe, or by detaching its upper part, and the pressure of the water would effectually prevent its opening; as, on several points of the pipes to be used for the above purpose, the pressure will be equal to six or eight atmospheres.

XXVI. *Me-*

XXVI. *Memoir upon the Mordants employed in the Art of Dyeing.* *By MM.* Thenard *and* Roard. *Read at the Physical and Mathematical Class of the French Institute.*

The name of *Mordant* is given, in the art of dyeing, to those substances which serve to produce a more intimate combination of colouring matters with the different stuffs, and to augment the brightness and beauty of them. This property belongs to a great number of saline and metallic substances: but those which possess it in the highest degree, and which, for this reason, are exclusively made use of by dyers, are alum, acetate of alumina, tartar, and the solutions of tin.

An examination and analysis of the effects produced by these mordants upon vegetable and animal substances, will form the subject of the memoir we have honour to submit to the Class. We shall divide it into four chapters, wherein we shall successively treat of the action of alum, of acetate of alumina, of alum and tartar, and of the solutions of tin, upon silk, wool, cotton, and thread, according to the methods most generally made use of in the art of dyeing.

CHAP. I.—*Of Alum.*

The manner of applying the alum varies according to the nature of the stuffs, and according to the colours we wish to obtain. Silks are permitted to macerate for several days in a solution of alum, sufficiently diluted for the salt not to crystallize. Wool is boiled for two hours in water, containing a fourth part of its weight of alum. Cotton and thread are soaked for at least twenty-four hours in warm concentrated solutions or alum, to which frequently some potass is added. It has hitherto been thought that in this operation the alum is decomposed, and that the alumina combines with the stuff, causing it thereby the more easily to take the colour when plunged into the dyeing bath; but the experiments we have made induce us to adopt a different opinion.

Art. 1.—*Analysis of the aluming of Silk.*

Ninety-five grammes of silk, well cleaned and perfectly purified, were infused in a glass vessel during six days, at the common temperature of the atmosphere, with four quarts of distilled water, containing 100 grammes of pure alum, which had been previously dissolved in it. After

standing

standing this time, the silk was taken out of the liquid, drained completely over the bath, and washed several times with distilled water, to separate that part of the mordant which had not combined with it. The alum bath and the washings were then evaported with the greatest care, and they afforded very transparent crystals of alum. These first products indicated pretty clearly the nature of the combination which had been formed with the silk during the steeping, and that the alum had not been decomposed. The alumed silk was then boiled in a mattras with six quarts of distilled water, the boiling liquor was poured off from it, and in this manner it was treated twelve times. The 72 quarts proceeding from these operations being evaporated, we obtained well formed crystals of alum, the quantity of which, added to that obtained from the bath, amounted to within two decigrammes of the 95 grammes originally employed, forming a loss of $\frac{1}{420}$ part only. If after each of the twelve washings we attempt to dye the silk, the colour is less deep, in proportion to the number of washings, so that after the twelfth the silk is not at all coloured. If the silk, after having thus been washed, is again impregnated with alum, it re-acquires the same property of retaining the colour which it had before the washing commenced. Hence results a very natural explanation of the reason why alumed silks take a deeper colour when the dyeing is commenced at a low temperature, than when they are plunged into boiling baths; it is because, in the one case, the action of the boiling water upon the mordant is so speedy, that there is not time for the colouring matter to fix upon it, and render the combination insoluble, whilst, in the other case, no such effect takes place.

Art. 2.—*Analysis of the Impregnation of Wool with Alum.*

After having thus ascertained the phænomena which take place in the aluming silk, it was necessary to continue the trials upon wool, and to employ for these experiments only perfectly pure materials, completely deprived of the carbonate of lime, which is generally contained in considerable quantity. To separate the whole of this, we boiled the wool several successive times in a mattras with weak muriatic acid, but in order to take up the last portions of this acid; we were obliged to make use of such large quantities of distilled water, that we were on the point of abandoning such tedious experiments, requiring so much time and patience, as well as the greatest care. The separation of all the muriatic acid from the first two hectogrammes of wool

wool which we purified, required 200 quarts of distilled water, at 100 degrees of heat (212 F.) divided into 20 successive operations, each occupying from seven to eight hours. When calcined and properly tried, it afforded neither lime nor muriatic acid.

One hundred grammes of this wool were alumed with the same care which had been taken with the silk. It was afterwards washed twenty times, employing six quarts of distilled water, heated to an hundred degrees, for each washing. Immediately after the aluming, this wool took a very deep colour, whilst, after the last washing, it would not take any more colour in the dyeing bath, than some of the same wool which had never been alumed. These experiments convinced us that the substance which had been fixed in the wool by aluming, and had caused it to receive so deep a colour in the first dyeing, had now been carried off by the water. The alum bath, when evaporated, afforded us, in the state of crystals, two-thirds of the quantity of alum we had originally employed; very nearly the whole of the remaining third part was obtained from the residue of the bath, in an uncrystallized state, and from the washings of the wool. This experiment was repeated several times, and always with the same result; but as this did not appear to us so decisive as the experiment upon silk, on account of the difficulty of separating the animal matter from the last portions of the alum bath, we alumed some wool in the cold, as we had done with the silk, being persuaded that in this case the bath would not sensibly dissolve this substance.

We alumed in the cold, some clean wool with all the precaution observed with the silk, and we obtained from the bath and the washings the alum employed in the operation, with a loss only of $\frac{1}{400}$ part; we were therefore assured, that in the aluming of all animal substances, the alum combines entirely with them, without undergoing any decomposition, and that it forms with them combinations more or less soluble, which have a great affinity for the colouring matters.

Art. 3.—*Analysis of the Impregnation of Cotton and Thread with Alum.*

Having freed some cotton, by the methods already mentioned, from all foreign matters, we macerated it for two days in a lukewarm solution of a given quantity of alum. After this operation the stuff took the dye remarkably well; but being treated with boiling distilled water, it lost

 the

the property of taking the colour in the dye-bath. The alum-bath and washings, when evaporated, afforded us all the alum we had employed. We separated this alum from the vegetable matter which it had dissolved in its different crystallizations. To do this did not require such a number of washings as were employed for the wool or the silk, because the combination of alum with vegetable substances is so weak, that soaking the alumed cotton in boiling water for a few minutes is sufficient to carry off the greatest part of the mordant. Cotton, therefore, ought to be dyed at a low temperature, since it is only after the colouring matter has rendered the combination insoluble, that it can support a great heat without being attacked. Thread treated in the same manner as cotton, afforded us the same results.

Art. 4.—*Analysis of the Impregnation of common Wool.*

The analyses we have already related, most decidedly demonstrate that in the aluming of all animal and vegetable substances, the alum combines with them without undergoing any decomposition; but we thought it was necessary to repeat the same experiments upon these substances in the state in which they are commonly met with in commerce, as we had done in their purified state. Wool, when impregnated with alum alone, always renders the bath turbid, which, upon cooling, throws down an abundant white precipitate, as has been observed by several chemists. Several analyses of this sediment, after being well washed, have constantly afforded us some sulphate of lime, saturated sulphate of alumina, and sometimes a little alumina. The bath contained a remarkable quantity of alum, of acidulated sulphate of potass, combined with a small proportion of animal matter. Upon the wool we found alum, and a very minute proportion of the precipitate. These experiments upon the sediment, formed in the alum bath, do not differ from those made by M. Berthollet; but this learned chemist not having examined the mother-waters, nor the alumed wool, has not given, as he himself says, a clear and precise explanation of the effects produced by alum and tartar in the operation of dyeing. These precipitates, obtained by treating common wool with alum, never take place with purified wool; and as these only differ from each other by the former containing some carbonate of lime, it was natural in this case to attribute to this substance the decomposition of a part of the alum.

We satisfied ourselves of this, by mixing in glass vessels

solutions

solutions of alum in boiling water with different proportions of pure carbonate of lime. We always found the alum was decomposed by the carbonate of lime, and that, if a sufficient quantity was added, there remained no part of the aluminous salt in solution. The mother-waters contained very acid sulphate of potass, and the sediment was formed of sulphate of lime and acidulate sulphate of alumina and potass; whence it follows, that the property possessed by common wool of forming a precipitate in the alum bath, and rendering the fluid very acid, is in reality owing to the carbonate of lime it contains. The same result was obtained by aluming common wool five or six successive times in the same bath. But in order to arrive at a general solution of this question, it was necessary to ascertain the nature of the precipitates formed in the solution of alum, by different alkaline and earthy substances. We took, therefore, alums with base of potass, and with base of ammonia, which we treated with ammonia and carbonate of potass, so as to leave in the solution but a slight excess of alum. The mother-waters evaporated, contained very acid sulphates of ammonia, of potass and ammonia, and of potass, according to the nature of the alum and of the precipitate employed. The sediment, which was acid sulphate of alumina and potass, or ammonia, treated with sulphuric acid, afforded alum and acidulated sulphate of alumina; boiled afterwards a great number of times with distilled water, it was converted into alum, sulphate of potass, and pure alumina. There was always a greater quantity of acidulated sulphate of potass than of alum, even in the last washings.

Solutions of alum, treated at a boiling heat with pure alumina, were converted into a very acid sulphate of potass, and into acidulated sulphate of alumina and potass. These results do not at all correspond with those obtained by M. Vauquelin in his experiments upon the alums of commerce, for we have never been able to obtain the saturated sulphate of alumina and potass, spoken of by that celebrated chemist.

Thus all the alkaline and earthy substances mixed in suitable proportions with solutions of alum, converted that salt into acidulated sulphate of potass, or ammonia, and into insoluble acid sulphate of alumina and potass or ammonia, for which reason we have named it the acidulated sulphate instead of the saturated sulphate, the name it has borne until now. It is evident, that if too great a quantity

M 2 of

of carbonate of lime be employed, and the same holds good with the carbonates of barytes and strontian, we shall only obtain alumina and the sulphates of potass, lime, barytes, or strontian. There remains no doubt, therefore, of the nature of the changes produced in the alum baths by the common wools, and of the prejudicial effects of alkalies in the baths intended for cottons; for the addition of these substances diminishes the quantity of alum, and even increases the acidity of the bath.

CHAP. II.

On the Impregnation of Vegetable and Animal Matters with Acetate of Alumina.

Wool, silk, cotton, and thread, in the different states in which these substances are employed for dyeing, were treated with acetate of alumina, which combined entirely with them. But as in exposing them to the air, or to a temperature a little elevated, the mordant always loses a small quantity of acid, it follows that the combination formed upon the stuff is an acetate with excess of base; thus, by treating it with boiling water, it is converted into acidulated acetate of alumina, which is dissolved, and into alumina which cannot be carried off by the water.

CHAP. III.

Art. 1.—*Of the Action of acidulated Tartrite of Potass on Wool.*

Purified wool was treated as in the former experiments with very pure cream of tartar, free from tartrite of lime, and formed directly by the tartaric acid and potass. This wool was washed a great number of times, until the last washing did not contain any of the principles which had been combined with it. The bath afforded by evaporation $\frac{3}{4}$ of the cream of tartar employed, or rather neutral tartrite of potass. The washings were very acid, and we obtained from them a small quantity of cream of tartar, and a very acid composition formed of tartarous acid and wool. These facts may be thought sufficiently to explain the phænomena which take place in impregnating wool with alum and tartar, since we already know from the experiments of M. Berthollet, that these two salts are not decomposed; and as we have shown that the wool combines completely with the alum, and that it acts upon the cream of tartar by separating the tartarous acid with which it unites in the most intimate manner. But in order to have these facts rigorously

rigorously demonstrated, we repeated this experiment, although a very tedious one, in the method already pointed out in the preceding chapters.

ART. 2.—*Of the Action of Alum and Tartar upon Wool.*

Before treating the wool with alum and cream of tartar, we made some trials of the reciprocal action of these two salts. We ascertained that water, at the temperature of 12° or 14°, (55 F.) holds in solution only $\frac{1}{150}$ part of its weight of cream of tartar, that boiling water dissolves $\frac{1}{30}$ of its weight, and that a mixture of equal parts of alum and cream of tartar, dissolves in $\frac{3}{5}$ the quantity of water required to dissolve the salts separately at the same temperature. These results do not differ from those already obtained by M. Berthollet, who has shown that alum has the property of increasing the solubility of cream of tartar.

If wool is alumed in the ordinary proportions, which are $\frac{1}{4}$ of the weight of the stuff of alum, and $\frac{1}{16}$ of cream of tartar, all the substances being perfectly pure, we obtain from the bath when evaporated, alum, cream of tartar, and a residue difficultly crystallizable, composed of tartrite of potass and an animal matter; the washings of the wool will give alum, a small quantity, scarcely appretiable, of cream of tartar, and a very acid combination, formed of a large quantity of tartarous acid, alum, and animal matter.

These experiments remove all uncertainty concerning many practical facts, which at present are only noticed by the dyer in a vague way, and point out to him the precise method of applying the mordants according to the nature of the colour he wishes to obtain. Indeed, since by making use of alum and tartar, the wool is impregnated with alum and a large quantity of tartarous acid, these two salts should never be employed together, except when the colour is susceptible of being heightened and rendered brighter by acids, as is the case with cochineal, madder, and kermes. On the contrary, alum should never be employed for wools intended to be dyed with woad or Brasil wood, the colour of which is easily altered or destroyed by acids. Among all the vegetable and animal substances, we have made choice of wool only for trial with alum and alum and tartar, because it is only with this substance these mordants are made use of in dyeing.

ART. 3.—*On the Action of Acids, and of some Salts employed as Mordants upon Wool.*

Although all researches hitherto made have been ineffectual

fectual to find a substitute for alum, we have, nevertheless, made trial of a great number of substances with wool, less, however, for the purpose of discovering the best mordants, than for determining the action of several substances, very soluble, and at the same time endowed with great powers. We boiled wool for two hours in water, in which were put small quantities of sulphuric, nitric, muriatic, and tartaric acids. In each instance, the wool, especially when combined with sulphuric acid, struck with cochineal and madder deeper colours than when impregnated with alum and tartar. No doubt, therefore, can be entertained of their superiority in similar cases; but of all the mordants we tried, there is not one which gives such bright colours as what are obtained by means of the acid tartrite of alumina (notwithstanding the opinion of M. Hausmann to the contrary). This salt would, in a great number of cases, be preferable to tartar and alum, if its price was not so much higher than theirs. Whilst we were occupied in inquiring with the greatest care into every thing relative to the nature and mode of combination of mordants with various stuffs, we did not forget to examine the several methods which have been adopted in all the workshops for a long time past, in order to ascertain if the proportions of alum and tartar, the most generally employed, were those the most suitable for the purpose, if the time employed for the alum bath was sufficient to impregnate the wool sufficiently, and if the exposure to the cool air afterwards, for several days, which is so generally thought necessary, is attended with the expected advantages.

Equal parts of the mordants, that is, half the weight of the stuff, produced no better effect than one-fourth; but between this quantity and one-twentieth part, the colours of cochineal, kermes, and madder, were weaker in proportion to the diminution of the quantity of the salts; whilst, on the contrary, the effects were reversed with woad and Brazil wood, so that in these last substances, the colour was deeper the more the salts were diminished. No difference could be observed in the colour whether the wools had been in the alum bath for two, four, or six hours; it is, therefore, useless to continue stuffs in the bath longer than two hours. Our experiments did not discover that there was any difference in the colour, whether the dyeing took place immediately after the aluming, or was protracted for some time, except only that wool impregnated with alum alone, produced a deeper colour with woad, after having been exposed some time to a cool air, which we attributed

attributed to the separation of the acidulated sulphate of potass, this being carried off with the uncombined mordant in drying.

CHAP. IV.

Art. 1.—*Of the Scarlet Colour.*

Scarlet is that bright and shining colour which is produced in wool by treating it with tartar, cochineal, and a highly oxidized solution of tin. Before the discovery of this method, for which we are entirely indebted to Drebbel, those colours were called scarlet which are produced in woollen stuffs by kermes or cochineal, when alum and tartar are employed as mordants. These processes for obtaining this colour have long been known in the dyeing houses, yet no theoretic investigations have been made into the phænomena which take place when a solution of tin is used with cream of tartar and cochineal. Dr. Bancroft attempted to explain what passes in the formation of this colour; but as his opinion does not appear to be founded on any experiments, we considered the question as not at all determined by his labours. We propose, therefore, in this fourth chapter, to determine the chemical nature of the combination formed upon wool by cochineal, tartar, and a solution of tin, and to make known the result of our inquiries upon the colour of scarlet.

Art. 2.—*Examination of the Precipitate formed by the Solution of Tin, and the acidulated Tartrite of Potass.*

All the substances employed by us in our experiments were perfectly pure, and we constantly made use of glass vessels and distilled water. Eighty grammes of acidulated tartrite of potass dissolved in three kilogrammes, and five hectogrammes * of distilled water, were macerated for two hours, at 100 degrees (212 F.) of heat, with one hundred and twenty-five grains of a solution of tin. The precipitate which we obtained was washed several times, and distilled in a small curved retort, the beak of which being plunged into lime water, there was disengaged a sensible quantity of carbonic acid. Proper re-agents indicated in other portions of it the presence of a great deal of tin and muriatic acid. Thus the cream of tartar and solution of tin are decomposed, and produce a precipitate, consisting of tartarous acid, and a great quantity of muriatic acid and tin. The mother-water contains tartrite of potass, acidulated tartrite, very acid muriate of tin, and a considerable

* About seven pints.

portion of precipitate, held in solution by excess of muriatic acid.

Very pure white wool, treated with the ordinary proportions of solution of tin and cream of tartar employed in dyeing scarlet, was washed a great number of times in boiling water, which carried off all the substances combined with it. These washings, collected and evaporated, afforded us the same principles we had before obtained from the precipitate formed by the solution of tin and cream of tartar; we also examined, in the same way, the action of cochineal, and found no difference in the results. From these facts we are to a certainty convinced, that the fine scarlet colour is produced by the wool being combined with colouring matter, tartarous acid, muriatic acid, and peroxide of tin. But we are mistaken, if we think the bath has no influence on the colour; for wool combined with the mordants we shall presently mention, and dyed with cochineal, never take the scarlet hue unless some acid be added, which causes the colour to pass from yellowish to red, and at length to a bright colour. This last experiment, and some others we shall relate towards the close of this memoir, proved to us that the wool is not coloured yellow by the combination it forms with the nitric acid in excess in the solution of tin, for this wool comes out perfectly white from all the boilings it undergoes with the tin, when no colouring matter is employed.

Art. 3.—*Of Tartrites of Tin, and some other Metallic Solutions.*

The proofs we have already given of the formation of scarlet, appear to us so decisive, that we should not have thought of increasing the number, had not the importance of the question induced us to extend further our labours on this subject.

We tried upon wool, in the usual proportions for dyeing scarlet, all the sulphates and muriates of antimony, bismuth, zinc, and arsenic. Some of these solutions afforded very agreeable colours, but very different from that we were seeking to obtain. We were more fortunate in our attempts with the tartrite of tin obtained from tartrate of potass and soda, and a highly oxidized muriate of tin. This salt dissolved in muriatic acid, and used in the operation of dyeing, afforded us a scarlet colour as beautiful and bright as those obtained by cream of tartar and a solution of tin. The tartrite of tin, also, dissolved in an excess of its own acid, produced very good effects; however, as this method

method would be more costly than the ordinary processes, it is best to employ the solution of this salt in muriatic acid. But, before recommending this mordant to be used in the dye houses, we intend to make trial of it in the large way, so as to determine precisely the expense of it, and what advantages will be obtained by its employment.

ART. 4.—*Experiments upon the Colour of Scarlet and Oxides of Tin.*

Scarlet, as we have already seen, is obtained by treating wool with determined proportions of cochineal, acidulated tartrite of potass, and a highly oxidized solution of tin. The operation of dyeing is divided into two parts: the first taking up an hour and a half, the latter half an hour; this division is necessary to produce a good colour, which would be weaker and more yellow if all the substances were mixed in the first operation, and applied to the wool for two hours. This circumstance is owing to the very acid state of the bath, which holds in solution a great part of the mordant, and of the colouring matter. We obtain the contrary effect when the mordants only are employed in the first operation, and the cochineal reserved for the second.

Pieces of very beautiful scarlet cloth, macerated in distilled water, at a boiling heat, gave out to the water a portion of their colour, and when the operation was finished, appeared only of a light flesh colour. The washings collected and evaporated were very acid, and contained, besides the colouring substance and animal matter, tartarous acid, muriatic acid, and oxide of tin. Scarlet, therefore, as we have already shown, is a combination in some measure soluble, which in parting with a small quantity of acid changes its shade, and may, by repeated washings at elevated temperatures, and with a large bulk of fluid, be rendered completely colourless.

It results from the experiments related in this memoir:

1st. That in aluming all vegetable and animal substances, it is not the alumina which combines with them, but the entire alum; and that when these matters are not purified, the lime which they contain, occasions a decomposition of a part of this mordant.

2. That all the alkaline and earthy bases, mixed with a solution of alum, decompose it, and convert it into acid sulphate of potass, and into an insoluble salt, less acid than alum, which may, by repeated washings, be converted into pure alumina, sulphate of potass, and alum.

3. That the acetate of alumina combines also in its entire

tire state with silk, wool, cotton, and thread; that this compound retains its acid but feebly, and loses a portion of it by simple exposure to the air; and that it is then changed into acid acetate of alumina, which is carried off by water, and into alumina which remains upon the stuffs.

4. That alum and tartar are not decomposed, but that the solubility of the latter is increased by the mixture; and that in impregnating wools either with tartar, or alum and tartar, the tartar alone is decomposed, that the tartarous acid and alum combine with the stuff, and tartrite of potass remains in the bath.

5. That the most powerful acids have the property, when combined with wool, of fixing the colouring matters, a property possessed in a high degree by the acid tartrite of alumina.

6. That alum and tartar cannot be employed indifferently for all colours, and that their proportions must depend upon the nature of the colouring matter; that the time of aluming should not be more than two hours, and that the exposure of the stuffs in a moist place, after the mordants are applied, is of no utility in augmenting the intensity of their colour.

7. That highly oxidized tartrite of tin, dissolved in muriatic acid, may supply the place of cream of tartar and the solution of tin in dyeing scarlet.

8. Lastly, that these experiments furnish some useful hints for combining mordants with the stuffs to be dyed, and for improving several of the processes of dyeing.

To complete these researches relative to the action of mordants, it would without doubt be necessary to determine, in the most accurate manner, the changes produced in these combinations by the colouring matters, when applied to the different stuffs; but these experiments, which we have already commenced, will form the subject of a second Memoir, to be hereafter presented to the Class.

XXVII. *An Account of the Smelting of Lead.* By Mr. John Sadler.

[Continued from vol. xxxviii. p. 376.]

*Cupola Smelting**.

"The process of smelting here described, appears to be defective in some points, which I will take the liberty to mention, and at the same time suggest the means of improvement;

* See an account of the present state of this art, in Mr. Farey's Derbyshire Report, vol. i. p. 386.—Editor.

provement; without, however, presuming to say, how far it may be expedient to adopt the proposed alterations; being sensible that what may appear very feasible in theory, or may even answer in small assays, may not be practicable in large works.

"The first alteration which I would propose to the consideration of the lead-smelters, is to substitute an horizontal chimney of two or three hundred yards in length, in the place of the perpendicular one now in use. In the preceding Essay, which was first published in 1778, mention is made of the probability of saving a large quantity of sublimed lead, by making the smoke which rises from the ore pass through an horizontal chimney, with various windings to condense the vapour. I have since conversed with some of the principal lead-smelters in Derbyshire, and find that I had overrated the quantity of this sublimed lead; the weight of the *scoria*, from a ton of ore, amounting to more than I had supposed. They were all of them, however, of opinion, that the plan I had proposed for saving the sublimate was a very rational one. But so difficult is it to wean artists from their ancient ways of operating, that I question very much whether any of them would ever have adopted the plan they approved, if an horizontal chimney, which was built a little time ago in Middleton Dale, for a quite different purpose, had not given them a full proof of the practicability of saving the sublimate of lead, which is lost in the ordinary method of smelting. This chimney was built on the side of a hill, to prevent some adjoining pastures from being injured by the smoke of the furnace. It not only answers that end, but it is found also to collect considerable quantities of lead, which is sublimed during the smelting of the ore. This sublimed lead is of a whitish cast, and is sold to the painters at ten or twelve pounds a ton; it might perhaps be converted into red lead with still more profit.

"A second circumstance to be attended to in the smelting of lead ore, is the saving the sulphur contained in it. The pure lead ore of Derbyshire contains about an eighth and a ninth part of its weight of sulphur; but as the ore which is smelted is never pure, being mixed with particles of *spar*, *cawk*, *limestone*, *brasil*, and other substances, which the miners call *deads*, we shall be high enough in our supposition, if we say that the ordinary ore contains a tenth of its weight of sulphur; it may not, probably, contain so much, but even a twelfth part, could it be collected at a small expense, would be an object of great importance

to

to the smelter. In the common method of smelting lead ore there is no appearance of the sulphur it contains; it is consumed by the flame of the furnace, as soon as it is separated from the ore. An attentive observer may, indeed, by looking into the furnace, distinguish a diversity in the colour of the flame at different periods of the process. During the first three or four hours after the ore is put into the furnace, the flame has a blueish tint; proceeding, no doubt, from the sulphur, which, in being sublimed from the ore, is inflamed; after all the sulphur is separated from the ore, the flame has a whitish cast; and then, and not before, the fire may be raised for finishing the operation; for if the fire be made strong before the sulphur be dispersed, the quantity of lead is less, probably for two reasons; the sulphur unites itself in part to the lead which is formed, and by this union becomes inseparable from it; for the sulphur cannot without much difficulty be separated from an artificial mixture of lead and sulphur, when the two ingredients have been fused together. 2. The sulphur whilst it continues united to the lead in the natural ore, renders the ore volatile, so that in a strong heat a great portion of it is driven off. *Hence, very sulphureous ores should be roasted for a long time with a gentle heat; and in this proper management of the fire principally consists the superiority of one smelter above another.*

"An old lead smelter informed me that he had often reduced a ton of ore to 16 hundred weight, by roasting it; but that he did not obtain more metal from it by a subsequent fusion, than if he had fluxed it without any previous roasting. This may be true of some sorts of ore, but it is not true of very sulphureous ores. Indeed the fire may be so regulated in a cupola furnace, as to make it answer the purpose of a roasting and a smelting-furnace at the same time. *I have seen much lead lost by smelting a ton of sulphureous ore in eight hours; which might have been saved, if the fire had at first been kept so gentle, as to have allowed twelve hours for finishing the operation.*

"Sulphur cannot be separated from lead ore in close vessels; and the lead ore melts with so small a degree of heat, that there may be more difficulty in procuring the sulphur from the ores of lead, than from those of copper or iron: however, I am far from thinking the matter impracticable, though I have not yet hit upon the method of doing it; and the following reflections may, perhaps, tend to supersede the necessity of collecting the sulphur in substance.

"When

"When it is said that the sulphur is consumed by the flame of the furnace as soon as it is separated from the ore, the reader will please to recollect that sulphur consists of two parts,—of an inflammable part, by which it is rendered combustible,—of an acid part, which is set at liberty, in the form of vapour, during the burning of the sulphur. Now this acid, though it may be driven out of the furnace in the form of vapour, yet is incapable of being thereby decomposed; it still continues to be an acid: and, could the vapour be condensed, might answer all the same purposes as the acid of vitriol; since all the acid of vitriol, now used in commerce, is actually procured from the burning of sulphur. That the fact, with respect to the acid not being decomposed, is as I have stated it, may be readily proved. The smoke which issues out of the chimney for some hours after each fresh charge of ore, has a suffocating smell, perfectly resembling the smell of burning brimstone; and if a wet cloth, or a wet hand, be held in it for a very short space of time, and afterwards applied to the tongue, a strong acid will be sensibly perceived. Various methods may be invented for condensing this acid vapour, and, probably, more commodious than the following one, which, however, I will just take the liberty of mentioning, as, if it should not succeed, the trial will be attended with very little expense.

"Supposing then an horizontal chimney to be built, let the end furthest from the fire be turned up by a tube of earthenware, or otherwise, so that the sulphureous acid may issue out in a direction parallel to the flue of the chimney, and at the distance of about a foot and a half above it. Let a number of large globular vessels be made of either glass or lead; each of these globes must have two necks, so as to be capable of being inserted into one another; let these vessels be placed on the flue of the chimney, the neck of the first being inserted into the tube through which we have supposed the sulphureous acid to issue, and the neck of the last being left open, for fear of injuring the draught of the furnace. Let each of these globular vessels contain a small quantity of water; then it is conceived that the heat of the flue will raise the water into a vapour, and that this watery vapour will be the means of condensing sulphureous acid vapour, if not wholly, at least in such a degree as may render the undertaking profitable. When the sulphur is all consumed, the draught of the furnace may be suffered to have its ordinary exit at the end of the horizontal chimney, by a very slight contrivance of a moveable damper.

damper. Since the first publication of the preceding Essay, I have seen an horizontal chimney at the copper works near Liverpool, where every thing I had said concerning the probability of saving sulphur by roasting lead ore, is verified with respect to copper ore; and I believe a patent has been granted to some individual for this mode of collecting sulphur. Sulphur might be obtained with equal facility from the *pyrites* which is found amongst coal, and this application of the pyrites might, probably, be more lucrative than the present one—making green vitriol.

"A third circumstance, which requires the utmost care of the lead-smelter, is the leaving as little lead as possible in the slag. Near every smelting-house there are thousands of tons of slag, which, when properly assayed, are found to yield from one-eighth to one-tenth of their weight of lead, though no person has yet discovered a method of extracting so much from them when smelted in large quantities; and indeed the smelters are so little able to obtain all the lead contained in them, that in many places they never attempt to extract any part of it: in some places where they do attempt it, I have known the proprietor of the slag allow the smelters 20*s*. for every pig of lead they procured of the value of 38*s*. besides furnishing them with fuel: and yet the men employed in such an unwholesome business, seldom made above 7*s*. a week of their labour. This fusion of the slag of a cupola furnace is made, as has been mentioned, at a hearth furnace; the coal cinder, which they use as fuel, and the slag are soon melted by the strong blast of the bellows into a black mass, which, when the fire is very strong, becomes a perfect glass; this black mass, even in its most liquid state, is very tenacious, and hinders many of the particles of lead from subsiding; and it being from time to time removed from the furnace, a considerable quantity of lead is left in it, and thereby lost. A principal part of the lead contained in the slag of the cupola furnace, is not, I apprehend, in the form of a metal, but in the form of a litharge or calcined lead: a portion of the lead, in being smelted from its ore, is calcined by the violence of the fire; this calcined lead is not only very vitrifiable of itself, but it helps to vitrify the spar which is mixed with the ore, and thus constitutes the liquid scoria: might it not be useful to throw a quantity of charcoal dust upon the liquid scoria in the cupola furnace, in order that the calcined lead might be converted into lead by uniting itself to the inflammable principle of the charcoal? Iron will not unite with lead, but it readily unites with sulphur; and when added

added to a mixture of lead and sulphur, it will absorb the sulphur, leaving the lead in its metallic form: might it not be useful to flux sulphureous lead ores in conjunction with the scales or other refuse pieces of iron, or even with some sorts of iron ore? The smelter's great care should be to extract as much lead as possible at the first operation of smelting the ore, and to leave the slag as poor as possible; but if he should still find either the slag of the cupola furnace, or that of the hearth furnace, containing much lead, (as that even of the hearth furnace certainly does,) he may, perhaps, find it worth his while to reduce the slag into a powder by a stamping mill, or by laying it in highways to be ground by the carts, and then he may separate the stony part of the slag from the metallic, by washing the whole in water, inasmuch as the metallic part is far heavier than the other.

"I estimated the weights of several pieces of slag, and found them to differ very much from each other; this difference is principally to be attributed to the different quantities of lead left in them.

Weight of a cubic foot of

	Avoir.oz.
Slag from a cupola furnace, where no lime was used	3742
Black slag from a hearth furnace...............	3652
Another piece..................................	3612
Black slag from another hearth furnace; struck fire with steel	3378
Black glass slag	3371"

XXVIII. *Extracts from Mr.* John Farey's *first Volume of Report to the Board of Agriculture, on Derbyshire*; giving an Account of the several* Rivers *in that County, and of the particular Strata intersected and exposed by the excavated* Valleys *through which they flow; of their Floods and of the Water-falls in their course, and elsewhere; with an Account of the Acres of surface from which each River collects its Waters: on the absence of* Lakes *in that County, &c.*

[The Readers of the Philosophical Magazine will recollect, that during the preparing and printing of the Volume above

* This Volume of important matter relating to the Surface, Stratification, and Minerals of Derbyshire and the borders of its seven adjacent Counties, purports to be intended as, and I sincerely hope in time will prove to be, *the first of a Series* of copious Reports, undertaken with the view of investigating and explaining the physical Geography, Stratification, and Minerals, of the British Islands; with information, which cannot fail of being important in a national point of view, of the uses to which the mineral products of our soil, are or may be applied.—Editor.

above mentioned, I was favoured by its indefatigable Author, with communications, respecting the numerous *Collieries* in or near Derbyshire, which are printed in my 35th volume, page 431; the various *Mines* of Lead, Zinc, Copper, &c. which are given in vol. xxxvii. page 106, and respecting the numerous *Hills* and the upper stratum of each, which will be found at page 161 of the same volume. On comparing the papers and lists above referred to, with the corresponding parts of the volume now before me, I find them so far from mere copies, that they seem essential auxiliaries of each other, as every new and different arrangement of a large series of facts and phænomena must prove, to the anxious inquirers after Geological or other truths. It is my intention, in an early number, to give a copy of the *Map of Ridges* and Hills, which has been mentioned and referred to, vol. xxxvii. p. 161; and wherein the total lengths and widths or extents and shapes, of the excavations between the several Ridges that separate the River-Districts of Derbyshire, will appear, and I have selected the account of the beds of these Rivers, &c. for insertion herein (as the first of some extracts which I mean to give occasionally from Mr. Farey's volume), as following up what is already begun in my Magazine, by the account of these Ridges and the Hills on them, and throwing some additional light on that very fundamental point of Geological Theory, the manner and circumstances of the *excavation or formation of Valleys* on the surface of the Earth, which it will be recollected, engaged the pens of two of my Correspondents in the 33d and 34th volumes: and I will take the present opportunity of saying, that observations of facts and discussions (temperately conducted) on *Geological subjects*, shall always receive attention, and as early insertion as possible in the Philosophical Magazine; and not less so, than if regard to uniformity in the sets of my volumes would have allowed me, to make a more express alteration in its Title than I have done, by calling it in future the *Philosophical and Geological Magazine*, as several of my ingenious Correspondents have wished.—Editor.]

1. *Streams and Rivers.*

In speaking of the Surface of Derbyshire, in the 1st Section of this Chapter, and describing the 41 Ridges of high Land, page 4, which are shown in the Map facing page 1, the

the names and situations of most of the Rivers in the District are pointed out, they have also been separately shown in the Map annexed to the original 4to. Report, and can readily be traced on any Map. I shall therefore proceed to point out some particulars of the course, and the nature of the bed, of each River; and give the space, or number of Acres nearly, on which each collects its water.

The *Trent* claims our first notice, as being the largest River in or near to Derbyshire, and as effecting the drainage of nearly ten-thirteenths of the surface of the County, viz. 477,500 Acres of it, out of 622,080 Acres, exclusive of the Idle, which also falls into the lower part of this River. The course of the Trent, from where it first touches the border of this County, $\frac{3}{4}$ *m.* N of Croxall, at the mouth of the Mease, until it leaves its border again, $1\frac{1}{2}$ *m.* E of Long-Eaton, at the mouth of the Erewash, is through a very wide excavated Vale in the Red Marl Strata, having a steep bank of these Strata close to the River, at Burrow Hill SSW of Walton, on the south of the River, at Scropley Hill E of Burton Church, at Bladon-Hill SW of Newton Solney, and at Holywell-Hill W of Repton: of Gravel Rock NW of Ingleby: and, of Red Marl and Freestone at Weston Cliff and Church, N of the River, which is the only place that the high ground approaches its stream on this side. In Donnington-park, and W and NE of it, the Cliffs of Red Marl and its Freestone, form the southern bank of the River: and at Red Hill, and thence to Thrumpton in Nottinghamshire, those of Red Marl and Gypsum do the same. The bottom of this noble Valley is less deep than the original Excavation in the Red Marl, being filled to a certain height, and levelled, with sandy small Quartz Gravel, mixed with a few Flints, and other distant Alluvia of this Island, and some few small thin Stones of the adjacent districts: the Map of Strata and Soils facing page 97, by the Brown colour thereon, will show how this Gravel is distributed.

The Vale of the Trent in Derbyshire, with the short Vales which drain by their Brooks into it, and by Rivulets without Names, occupy together about 70,000 Acres of the surface of Derbyshire; this being exclusive of the Vales or Drainages of the Erewash, Derwent, and Dove on the north, and the Mease on the south of Trent, and of their Collateral Streams.

The lowest five miles of the Trent, where it bounds upon Derbyshire, from the mouth of the Erewash River to the entrance of the Trent and Mersey Canal, at Wilden-Ferry in Shardlow, is now the only *Navigable River* remaining

in or near to Derbyshire, the Navigation from Wilden-Ferry up to Burton Bridge, which was made by the Earl of Uxbridge, in pursuance of the Acts of the 10th and 11th of William III., having been discontinued in the year 1805, in consequence of an agreement with Hugh Henshall and Co. the Proprietors of the Trent and Mersey Canal, which runs by its side (see Sect. 3, of Chap. XVI.*); and the Navigation on the Derwent River, from Wilden-Ferry up to Derby, having been discontinued since 1794, when the Derby Canals were finished. From this five miles of Navigation on the Trent River, the Loughborough Navigation, by the side of the Soar, branches to the south, and the Erewash Canal on the north, nearly opposite to each other.

The *Derwent* is the principal River of Derbyshire, collecting the whole of its waters from the surface of this County, except from about 5000 Acres in Yorkshire, near its source on the east side, and from 12,000 Acres in Nottinghamshire, at one of the heads of the Amber branch to this River.

The smaller Rivers or branches to the Derwent on its east side, are the *Bootle* and the *Amber*, and on its west side the *Morledge*, *Ecclesburn*, *Bradford* and *Lathkil*, *Wye*, *Noe*, and *Ashop*, besides smaller Brooks and Rivulets, which are reckoned with the Derwent itself, and the whole space which these occupy, including the 17,000 Acres above mentioned, is 288,500 Acres of surface, draining to and venting its waters into the Trent at Wilden-Ferry, above mentioned.

The course of the *Derwent* from Wilden-Ferry up to the great Derbyshire Fault† E of Allestry (see p. 146), is very widely excavated in the Red Marl Strata, and partially filled again with sandy Quartz Gravel, mixed with thin and light Bolders of Limestone, particularly in the upper part of this distance: the present channel of the River closely approaches the steep bank of Red Marl at Burrowash Mills, and again for some distance from the north end of Derby Town to Darley-Abbey. For about a mile, between the Fault above mentioned and the great zigzag Fault‡ SE of

* [This refers to the *Second* Volume (if it can be brought into that space) of the Report, on which I understand the Author to have been so long and assiduously engaged, and which is now in great forwardness: and which I doubt not, will prove when published, as deeply interesting to the Agriculturist and political Œconomist, as the present one, containing only the *first* Chapter, promises to be to the Mineralogist and Geologist.—EDITOR.]

† [See page 29, and plate I. of my present volume.—EDITOR.]

‡ [See pages 31 and 32, and plate I.—Ibid.]

Bur-

Bur-Hill (see page 162), the Excavation is immensely deep and wide into the upper part of the Coal Series, as I judge; from thence for about $2\frac{1}{2}$ *m.* the Excavation is in the Lime-stone Shale, the River approaching a Hill of Lime-stone Shale at Bur-Hill, W of Little Eaton, and others, in a range called Duffield Bank, having the 1st Grit Rock upon them; the Quartz Gravel floor to the Valley, extends up as far as this Excavation in Shale near Makeney, but no further. Between Milford and Makeney, the River is deeply and suddenly excavated in the 1st Grit Rock, which is there crossing to the west side of it, and the River then for about 2 *m.* has its course in the 1st Coal-shale, and the Argillaceous Grit beds in it, crossing the line of Section in Mr. Whitehurst's Plate II.*, 2nd Edit. of his "Inquiry," near the SW corner of Belper Town; the 2nd Grit Rock upon it, being cut entirely through at the N end of the Town, and a large Hummock of it left to the W, which the Wirksworth Road crosses. For about the next mile and quarter, the Excavation is again made very deep in the 1st Grit Rock, up to Toad-moor Bridge at Blundon-Ford, near the mouth of the Amber, and thence the same is cut in the Limestone Shale, to Cromford Bridge, having entered the western edge of the great Denudation around Crich (see page 171), the 1st Grit forms prodigious Cliffs in the Heights on each side the River, up to Coddington, near the mouth of Wakebridge Sough (now driving to the Crich Cliff Mines), on the west side, these Cliffs of 1st Grit turn off, on the north side of Cromford Moor, to Barehill Edge Hill, and on the east side they terminate abruptly at a Fault.

At Cromford Bridge the Excavation enters on the 1st Lime Rock, and having cut through this, at the Paper Mill in Matlock-Bath Dale (see page 68), it crosses the 1st Toadstone (which is here crossing the River to the east bank, see page 281); from hence for about $\frac{2}{3}$ of a mile, the bed of the River is on the 2nd Lime Rock: the 1st Toadstone then again crosses to the west side, and immediately the 1st Lime Rock does the same: and then the River runs for a short distance upon an Excavation in a sunk piece or Trough of Shale, and quickly after, by a rapid rise of the measures towards the north, the 1st Lime, and then the 1st Toadstone, again cross the River, and immediately the 2nd Lime Rock does the same; and the River then for about the $\frac{1}{6}$ part of a mile, at the foot of the High Tor, runs upon

* [See plate II. in my 31st volume.—EDITOR.]

2nd

2nd Toadstone*, as shown in the Section in *Plate* V. facing page 129, see also page 243; the main trunk of the Derwent being here deeper excavated in the series of Strata, than in any other part of its course. Near the north end of the High Tor, the 2nd Lime Rock again crosses the River to the west, and the 1st Toadstone also; and the River runs in or upon the 1st Lime Rock, until about half a mile above Matlock Bridge, when the same gets again upon the great Limestone Shale (as below Cromford Bridge and below Milford Bridge), and continues for many miles to run in deep excavations in this Shale, and the Shale Grit-stone which it sometimes contains (except touching a denudated patch of 1st Lime in Wensley, opposite Darley Church, see p. 243), and having massive Cliffs, often, of the 1st Grit in the heights above the River, until near its source upon this 1st Grit Rock, at the place called the Trough on the Grand Ridge, at the Bounds of Yorkshire, as mentioned page 4.

I shall now proceed to mention briefly, the principal Strata traversed by each of the smaller Rivers branching from the main trunk of the Derwent above described, in order as above, viz.

The *Bootle* Rivulet or Brook, joins the Derwent S of Little-Eaton, its course thence up to Coxbench being near to the great zigzag Fault, upon the upper part of the Coal Series; at Coxbench it crosses the 3rd Grit Rock, then the 3rd Coal-shale, the 4th Grit, and so on ascending the Series, to its source, near Ripley Town; and its branch from Smalley also, ascends the Series towards its course.

The *Amber* River empties itself into the Derwent at Toadmoor Bridge, upon the Limestone Shale, and continues therein and in Shale Grit-stone, until E of Bull-bridge Aqueduct; it then crosses the 1st Grit (with a rapid E dip), and then the 1st Coal shale, 2nd Grit, 2nd Coal-shale, &c. to Pentrich-lane, where it has got upon the 5th Grit or higher, when turning northward, its course follows nearly the edges of the same Strata to Ford, NW of Higham, where it turns NW and crosses the 4th Grit, the 3rd Coal-shale, 3rd Grit, &c. until near Mill-town its Excavation

* The late ingenious Mr. John Whitehurst, erred in asserting, in both editions of his "Inquiry concerning the Earth," that the Derwent here runs on loose and broken stuff, between the 2nd and the 1st Toadstone (see also, the Translation of Werner's "New Theory of Veins," Supplement, p. 234); since the publication of Mr. Whitehurst's Work, the Miners having driven a Gate across *under the River*, in solid and unbroken Measures.—See the Philosophical Magazine, vol. xxxi. p. 36.

crosses

crosses the 1st Grit, and enters the highly curious denudated Dale of Ashover, descending the Series on to the Limestone Shale, 1st Lime, and 1st Toadstone, which is excavated for near a mile (see p. 171 and 242), and then its course ascends to the 1st Lime, the Limestone Shale, the 1st Grit, near Bowers Mill, and takes its rise on the 1st Coal-shale, near to Moor-Hall in Ashover. The other main branch of this River, from Toad-hole Furnace eastward, continues to ascend the series of Coal-measures, till crossing the zigzag Fault W of Sutton in Ashfield in Nottinghamshire, it has its source from the edge of the yellow Lime.

The *Morledge* Rivulet or Brook, falls into the Derwent in Derby Town, on Red Marl and Gravel, its various ramifications being excavated in Red Marl, except its several extreme northern branches, which cross the great Derbyshire Fault, between Allestry Town and Mansel-park, and are excavated in the great Limestone Shale, or in the Quartz Gravel with which it is there locally covered.

The *Ecclesburn* River falls into the Derwent at Duffield on the great Limestone Shale, and in which it is excavated, through all its ramifications, except that, at its sources near Wirksworth, these Excavations extend into the 1st, and the 3rd, and 4th Limestones; and that on the south of Turnditch, a local patch of the Shale Limestone is cut and laid bare by a branch of these Excavations, see p. 230.

The *Bradford* and *Lathkil* pour their united streams into the Wye, west of Great Rowsley, near its junction with the Derwent, on Limestone Shale: through which they are soon excavated, so as to lay bare the 1st Lime Rock below Alport (see page 68), where the Lathkil and the Bradford meet, on a bed of Tufa, as observed page 458; from hence the course of the *Bradford* proceeds westward in the 1st Lime Rock, which it cuts through on the SW of Yolgrave, and lays bare the 1st Toadstone for a short space (see page 243), when it crosses the great Bakewell Fault* (see p. 291, Note), and again ascends the Lime and skirts the Shale, which it ascends near Gratton, taking its rise upon this stratum near Elton. The *Lathkil* Excavation pursues the 1st Lime to the south side of Over-Haddon, where it descends the Series on the 1st Toadstone, cuts through it, and lays bare a patch of 2nd Lime, as mentioned, page 243; but which not being excavated so deep as the Toadstone below, occasions a sudden fall in the River, whose course, after crossing the great Bakewell Fault (see p. 291, Note),

* [See page 34, and plate I. of my present volume.—EDITOR.]

 again

again ascends on to the 1st Lime, in which it is deeply cut (page 68) up to Monyash, where it approaches the basset of the 1st Toadstone; but turning to the NW, it keeps in the 1st Lime till near the branching of the Taddington and Flagg Roads, where it crosses the 1st Toadstone basset, and proceeds in the 2nd Lime, till opposite the Wells in Flagg Village, where it crosses the basset of the 2nd Toadstone, and then branches in different excavations in the 3rd Lime Rock, wherein the Vales terminate, but the water seldom runs on the surface above Monyash.

The *Wye*. This most interesting River empties itself into the Derwent at Great Rowsley, upon the Limestone Shale, as mentioned above, and on the south side of Haddon-Hall crosses the great Bakewell Fault (see p. 290, Note), which brings up the 1st Lime, in which the Vale is excavated for a short distance, and then again in the Shale up to Bakewell Town, where the Lime, rising rapidly NW, is cut again, and at the Cotton-Mill the excavation enters the 1st Toadstone (page 242), and continues in it, until crossing again the great Bakewell Fault, the Shale and Shale Limestone are then excavated, up to Ashford and beyond, when the 1st Lime is again cut through, the 1st Toadstone, 2nd Lime, and an Excavation made in the 2nd Toadstone, at the west front of Fin Copt Hill (see page 33), which in this respect, and its number of Strata, resembles Matlock High-Tor, represented in *Plate* V.* facing page 129. From hence through Monsal Dale (page 69), the 2nd Toadstone is in the bottom and west side of the Dale, and below the mouth of Cressbrook Dale the Excavation enters on the 3rd Limestone, and continues the same through Miller's Dale (pages 69 and 243), where the 3rd Lime is cut through for a $\frac{1}{4}$ of a mile, and shows the 3rd Toadstone in the bottom of the Dale. In Wye Wood in Wormhill, near Chee Tor, the River crosses the basset of the 3rd Toadstone, and from thence all the way to Mill Dale, near Buxton (page 69), the Excavation is in the 4th Lime Rock: in Mill Dale the 3rd Toadstone is again crossed with a N dip, and the Excavation for about $\frac{1}{4}$ of a mile is again in the 3rd Lime, to the great Limestone Fault †, near Mill-Dale Bridge at Buxton Town's end (page 287); from whence turning W, the Excavation proceeds in Shale on the north side of the Baths, and so continues to its sources near the Grand Ridge by the Manchester, Macclesfield, and Leek Roads.

The *Noe* River falls into the Derwent at Malham- (or My-

* [See plate II. in my 31st volume.—EDITOR.]

† [See pages 31 and 32, and plate I. in my present volume.—Ibid.]

tham-)

tham-) bridge in Hathersage, on the Limestone Shale, and is excavated therein through its whole length to Edale-Head, and to Castleton.

The *Ashop* River falls into the Derwent at Cock-Bridge, south of Darwent-Chapel, on the Limestone Shale, and all its different branches are excavated therein, except some of their extreme ends, which penetrate the 1st Grit, on the heights.

Thus it appears, that the Derwent River, which collects its water from very deep Excavations in the *lowest* known Stratum in all this District, the 4th Lime Rock, both by its Wye branch and its Noe branch from Castleton Peaks Hole (see page 289), conveys the same on to the *highest* known Stratum of the County, the Red Marl; and a similar remark will apply to the Dove River, of which I shall next treat.

The *Dove* River empties itself into the Trent at Newton-Solney Ford, on Red Marl covered by sandy Quartz Gravel, about a mile above which it passes under the Trent and Mersey Canal, through twelve low Aqueduct Arches, from whence for many miles its course is very widely excavated in the Red Marl Strata, and sandy Quartz Gravel mixed with thin rounded Limestones, is lodged as a floor in the bottom of this Valley, in so regular a manner, as to form flat Meadows (occasionally flooded) from $\frac{1}{2}$ to 2 miles wide, the adjacent heights being composed of Red Marl in horizontal strata; which at Row-Bank contain layers of Gypsum, near Coton in Hanbury, Staffordshire, and in other places near, see p. 151. Above Hanging-Bridge, on the Road from Ashburne to Leek, the great Derbyshire Fault (see p. 146) crosses this River, and suddenly terminates the Red Marl, bringing the Limestone Shale opposite to it on the north side, and in which, and the Shale Limestone belonging to it, the Dove Valley is excavated, to the crossing of the great Limestone Fault (see page 283) at the entrance of Dove Dale, near Thorpe. For a considerable distance above and below Hanging-Bridge, a vast mass of sandy Quartz Gravel Rock ? is lodged, and in which the Valley of Dove seems excavated; about $\frac{3}{4}$ *m.* above Mappleton, the Quartz Gravel in the Vale ends, and above this, the small quantity of Alluvia which is lodged in the bottoms of the Vales, consist of thin Limestones, and other native alluvial matters. From the great Fault last mentioned, the highly curious Dove Dale commences (see page 66), having the two surprising Hills of 4th Limestone, Bunster on the W and Thorpe-Cloud on the E, at the entrance of the Dale,

and between which the Excavation is very narrow, and the Rocks precipitous; and so it continues, with a few local exceptions, for near 5 *m.*, the Dove running, in great part of this distance, upon lower Strata in this immense 4th Lime Rock, and in the general Series, than are perhaps any where else visible in the British Islands. For about $\frac{1}{4}$ *m.*, after crossing the great Limestone Fault again, near Wolfscote Hall (see p. 286), the Excavation is partly in Shale on the W, and partly in 4th Lime on the E, when again crossing the Fault, the Excavation passes again through the 4th Limestone for about $\frac{1}{8}$ *m.* forming Beresford Dale (see page 64), and finally crossing the Fault at the north end of this Dale, its further course for several miles is in the Limestone Shale, often skirting close to the great Fault and 4th Lime Rock, till crossing the Buxton and Leek Road (about $\frac{1}{2}$ *m.* N of what is usually called Dove-head, at the bounds of Derbyshire), it soon after enters the 1st Grit Rock, which it cuts through between the great and middle Axe-edge Hills (see p. 17); the Dove taking its rise in the bog upon the 1st Grit and 1st Coal-shale, near Thatch-marsh Colliery.

The *Schoo* River falls into the Dove about $\frac{1}{4}$ *m.* below Hanging-Bridge in Ashburne Parish, probably on Coal-measures covered by Gravel (see page 159), and is excavated therein till near the Church at Ashburne, when the great Derbyshire Fault above referred to, is crossed obliquely, and the Excavation continues in Limestone Shale, and through Shale Limestone therein at Agnes-meadow and thence to Atlow, and proceeds again through Limestone Shale, to its source at Stainborough near Hopton; near to the great Limestone Fault, which a dry branch of this River's Excavations crosses (page 283), and proceeds some distance in the 3rd Toadstone and 4th Lime, NW of Hopton.

The *Dane* is a River in the Western Drainage of the Island, which having its source in the County of Derby, passes Congleton, unites with the Weaver, and falls into the Mersey. At Congleton in Cheshire, the Excavation for this River is in Red Marl, which continues to some distance above Northrode, where the continuation of the great Derbyshire Fault* crosses the Dane (see page 146): the Excavation then probably crosses a corner of the upper Coal Series; but soon crosses another great Fault, and enters the Limestone Shale, which and the Shale Grit-stone in it, it pursues till about $\frac{3}{4}$ *m.* above Dane Bridge in Win-

* [See page 30, and plate I. in my present volume.—EDITOR.]

cle-

cle-Chapel; the Excavation then pursues the line of a Fault, in Shale on the N and 1st Grit on the S; it leaves this Fault and cuts through the 1st Grit to Gradbatch, where it enters the 1st Coal-shale, the 2nd Grit and the 2nd Coal-shale; when a Fault near Birchen-Clough, again brings up the Limestone Shale, in which the Excavation proceeds a short distance, and then cuts through the 1st Grit Rock to Paniers-pool Bridge, at the corners of Cheshire, Staffordshire, and Derbyshire; whence it proceeds N a little way in the 1st Grit, and crosses a Fault at Gallywood-House, into the 2nd Coal-shale, which it pursues past Dane-head Colliery, and then for a considerable distance through the 2nd Grit Rock to Thatch-marsh Colliery, and on to the 1st Coal-shale, where the Dane River originates, from the same Bog which gives rise to the Dove, page 479.

The *Goyte* also is a western River, which uniting with the Ethrow at Water-meetings in Ludworth, forms there the celebrated Mersey, which runs to Stockport and Liverpool: the Water-meetings being in an Excavation in the 2nd Coal-shale, which the course of the Goyte pursues up to Marple-bridge, and there enters the 2nd Grit Rock, which it cuts through, and exposes the 1st Coal-shale in the bottom of the Dale, for some distance above and below Mellor-Mills: the Excavation then again enters and pursues the 2nd Grit, to the crossing of the New-Mills and Marple new Road, when the Rock is again quite cut through, and exposes the 1st Coal-shale for a short distance; then the 2nd Grit is again crossed, and the 2nd Coal-shale, and the Goyte Excavation passes through the romantic New-Mills-Dale (see page 70) in the 3rd Grit Rock; which Rock it pursues almost to Bottom-Hall, and then is in the 2nd Coal-shale, till above Whaley-bridge: the 2nd Rock is then pursued to near Taxhall, where the Excavation is in or adjoins a Hummock of the 2nd Coal-shale, for about a mile near Shallcross-Colliery: near Ferneylee the River again runs on the 2nd Grit, which continues to Goyte-moss, where the Goyte originates on the 2nd Coal-shale near Goyte moss E Colliery.

The *Ethrow* River, which discharges into the Mersey at Water-meetings in Ludworth, as before observed, is there excavated in the 2nd Coal-shale, which it pursues to Wood-seats in Charlesworth, and then its course is cut through Cliffs of the 3rd Rock for near a mile, yet it enters again on the 2nd Coal-shale, and pursues it to Wolley-Bridge on the Glossop and Mottram Road; then the 2nd Grit Rock is crossed, and the 1st Coal-shale, at Water-side Mills, the Excavation

Excavation entering the 1st Grit Rock, which is soon cut through; and it pursues a large patch of the Limestone Shale laid bare in the Valley, on which the River runs till within about ¾ of a mile of the bounds of Yorkshire, when the Excavation again encounters the 1st Grit Rock, and cuts through it, soon after passing the corners of Derby, York, and Chester Counties, when it enters the 1st Coal-shale, on which the Ethrow rises SW of Lady-cross Hill in the Penistone Road.

The *Shelf* Rivulet or Brook falls into the Ethrow on the N side of the Roman Station called Melandra Castle, in an Excavation in the 2nd Coal-shale, partly filled with foreign Alluvia. On the S of Dinting, the 2nd Grit Rock is crossed, and the 1st Coal-shale; at Bridge-end the Excavation of the 1st Grit Rock commences, and it is cut through at the E end of Glossop Town and Mills, the remaining deep Excavation being in the Limestone Shale, and the source of the Shelf is in the Bogs on the same, N of Doctor-Gate Bridle Road.

The *Sheaf* River falls into the Don in the Town of Sheffield in Yorkshire, upon the 9th Grit Rock, the Ponds Colliery being excavated underneath it: between this and Heely-mill, where the Sheaf touches upon Derbyshire, the Excavation has passed through the 8th Coal-shale, the 8th Grit Rock, the 7th Coal-shale, &c. and arrived on the 4th Coal-shale; in about ¾ *m.* more south, it has cut through the 4th Grit Rock, and from thence having entered Derbyshire near Oak-Mills, to near the north end of Totley Town, it runs upon the 3rd Coal-shale or great Crowstone-shale; at Totley it cuts through the 3rd Grit Rock, crosses the 2nd Coal-shale, and originates in the 2nd Grit Rock, in Strawberry-Leys Farm on the high or East Moors.

The *Rother* River falls into the Don about ½ *m.* above Rotherham-Bridge in Yorkshire, on the salmon-coloured Grit Rock, in which it is excavated, to Catcliff, and then through other parts of the Coal Series, which I have not yet thoroughly determined, to the SW corner of Folken Wood, where it crosses the 13th Grit Rock, and pursues the 12th Coal-shale, having touched the County of Derby above Woodhouse Mill, and entered it at the mouth of the Gannow Rivulet, till within ½ *m.* of Killamarsh Bridge, and there crosses the 12th Grit Rock, then the 11th Coal-shale and 11th Rock, and the 10th Coal-shale and Rock, just above the Bridge abovementioned; the Excavation then continues in the 9th Coal-shale to Renishaw Bridge, where the 10th Rock again crosses the River, and soon after the

10th

10th Coal-shale and 11th Rock do the same; and the Excavation proceeds in the 11th Coal-shale till near Staveley Bridge, when the 12th Rock is crossed, the 12th Coal-shale is then pursued for a short distance and the 12th Rock is again crossed; the Series is then descended, through the 11th Coal-shale and Rock, the 10th and 9th to the 8th Rock on the NW of Brimmington, laid bare by the Calow and Bull-Close Denudation, see page 163; after which the Series is ascended again in like manner by the channel of the River to the 10th Rock, above Wildens-mill, and in this Rock the Excavation proceeds up the Trough between Chesterfield and Hady, to the Bridge on the London Road above Chesterfield, having, opposite the Iron-Furnace, cut through the Rock and exposed the 9th Coal-shale for a short distance: from the Bridge last mentioned as far as Park-House Mill above North Winfield, the 10th Coal-shale is followed, the Rother taking its rise on this same Stratum at Littleworth near Stretton.

The *Hipper* River falls into the Rother at the SE end of Chesterfield, on the 10th Grit Rock, in which it continues to be excavated for $\frac{3}{4}$ *m.*, then the 9th Coal-shale for about the same space, then the 9th Rock, the 8th Coal-shale, and so on, descending the Series to near Holy-moor-side, where the 4th Grit Rock is crossed, the Excavation then pursues the 3rd Coal shale for $\frac{3}{4}$ *m.*, and then cuts through the 3rd Grit, and takes its rise on the 2nd Coal-shale on the W side of Harwood-Grange in Beeley.

The *Dolee* River falls into the Rother near Hague, below Staveley, on the 11th Coal-shale; its Excavation cuts through the 12th Rock below the Aqueduct Bridge of the Chesterfield Canal over this River, which stands on the 12th Coal-shale; at Netherthorp it cuts through the 13th Rock, and pursues Coal-measures which I am not thoroughly acquainted with, to Sutton Water-Mill, from whence it follows nearly the course of the great zigzag Fault for some distance (see page 162), and then leaves it on its E side; on the SW of Heath Church the 13th Rock is again crossed, and the 13th Coal-shale, and the 12th Rock is pursued, until it terminates abruptly at Stainsby Water-Mill, where the great zigzag Fault is again crossed; and the Measures which basset from under the yellow Lime are pursued by the Excavation, the rise of this River being near Over-Moor on the Tibshelf and Mansfield Road: about 1000 acres in Nottinghamshire to the eastward of this main branch, draining into it, as shown in the Map of Ridges facing page 1.

The

The *Idle* is a River of Nottinghamshire and Yorkshire, which falls into the Trent at Stockwith, having several heads or principal branches, four of which rise in Derbyshire upon the yellow Lime, and continue upon the same, until they quit the County, soon after which they each enter the Sherwood Gravel: one of these streams, which rises on the E of Bolsover, passes through a curiously excavated Valley in the Lime, called Markland-Gripes, on the NE of Elmton, see page 68, and through another in a lifted part of the yellow Lime, called Cresswell-Crags,* adjoining Nottinghamshire. At Walley old Furnace near Over-Langwith, a branch of the Palter is deeply excavated in the Lime; and so is the Medon, about the Cotton-Mills at Plesley old Forge: the Excavations for this last stream from Plesley up to Hardwick Park and Teversall, and at Stoney-Houghton, lay bare the blue beds of Lime in blue Clay, belonging to the yellow Lime Strata, see page 157, and so does the stream first mentioned at Walls near Knitaker, &c.: and the branches of the Leen near Cinder-Hill in Nottinghamshire, seem to do the same thing, see p. 452.

The *Erewash* River falls into the Trent at Barton-Ferry, in a wide Excavation in Red Marl, partly filled with sandy Quartz Gravel: about a mile below Sandiacre, hills of Red Marl commence on each side, and continue, with the Gravel flat in the bottom of the Valley, to Stapleford-Mill, where the great Derbyshire Fault (see page 146) crosses this River, and its Excavation, which is then very wide, proceeds in the upper part of the Coal Series greatly raised, until somewhere about the Road from Ilkeston to Cossall, where the zigzag Fault also crosses (see pages 162), and the Excavation then continues in lower parts of the Coal Series, not yet completely explored, until opposite the mouth of Golden-Valley at the NE corner of Codnor-park, where it enters the skirt of a curious local Denudation (see page 164), which in about a Mile it leaves again, and continues to ascend the series of strata until near Langton Hall in Kirkby, Nottinghamshire; where it again crosses the zigzag Fault, and the Excavation ascends the Coal Strata basseting from under the yellow Lime, which also it at length intersects, south of Kirkby, crosses its blue beds and Clay, and originates on the NE of Kirkby, near to the edge of the Sherwood Forest Gravel.

The *Nutbrook* Rivulet falls into the Erewash S of Trowel, and has a wide Excavation in the upper part of the Coal Series for ¾ *m.*, when it intersects and follows the line of

* [This is now supposed, an *upper* Rock; see my present vol. p. 105.—Ed.]

the

the zigzag Fault to near Kirk-Hallam, and then enters on a lower part of the Series: it originates on Coal-measures W of Heanor.

The *Mease* River falls into the Trent north of Croxall, in a wide Excavation in Red Marl partially filled with sandy Quartz Gravel, which extends up the Vale of the Mease a little above Croxall, from whence the Vale is excavated in Red Marl, with occasional patches of Quartz Gravel on it, sometimes in Derbyshire and sometimes in Leicestershire, to near the Aqueduct-Bridge at Hot-Wharf, WSW of Measham, near which a great Fault is crossed, and the Excavation enters the Ashby-de la Zouch Coal-Field, and in which it is cut, principally in a Red Clay, on which this River originates, on Smithsby Common N of the Town.

The *Sence* is a River of Leicestershire, which falls into the Anchor N of Atherstone, and whose waters are conveyed thence by means of the Tame, into the Trent, which is here mentioned, on account of its draining the detached parish of Ravenstone belonging to Derbyshire, in which the Valleys are mostly excavated in Red Clay belonging to the Ashby-de-la-Zouch Coal-Field.

The above description of the Beds or lowest Excavations of the principal Valleys in and near Derbyshire, will I trust be found useful, and important to observers of the Stratification and Minerals, of this curious District: it would have been desirable, to have mentioned the series of strata in the sides of the Valleys in more instances, but for the unavoidable attention to brevity in this place; yet as the tops of the Hills are ascertained in so many places, by the List at page 16, and the sides of the more remarkable Valleys, by the List, page 64, it is hoped that no serious difficulties will occur, to prevent the understanding and examining of the explanation which I have offered herein, of the Subterranean Geography of the District, novel and difficult as the attempt may appear.

The Rivers of Derbyshire are tolerably supplied with *Fish*, as will be further noticed in the beginning of Chap. XVI.: they are not much infested by *Weeds*, owing to the rapidity in the currents of most of them, yet none of them are permanently thick or discoloured.

It has been often remarked, that some of the Rivers of this District are *warmer* than usual, and rarely freeze, the Derwent in particular, owing as it is said, to the many warm Springs which vent into them: when however the very inconsiderable quantity of such warm Spring Water and its small elevation of temperature is considered, as also, that

that there is nothing like a general warmth perceivable in the Strata any where, as those fond of deriving Toadstone and every thing else from subterranean Fire have pretended (see p. 275), it seems more natural to refer the circumstance, as far as it is true, to the great depth and narrowness of the Valleys, preserving the temperature longer than in more open situations.

After long dry weather the Rivers and Brooks here, as might be expected with such rapid falls, suffer considerable *Droughts*, and are quite dried up often, in places where at other times the torrents are tremendous: a remarkable drought is recorded in the year 1661, in which it was said, but not truly I think, that the Derwent was dried up at Derby. See an account of the fluctuation of the Rain at Chatsworth in the last 50 years, at page 99.

It has been remarked, that considerable *Floods* usually follow *Rain* with the wind blowing down the course of the Rivers. The Dove seems particularly subject to sudden Floods, which inundate its fine expanse of Meadows. Under this head it may be proper to mention, that in 1587 the Derwent was greatly swelled by a Flood, which carred away St. Mary's Bridge: in 1610, and again in 1673, the Morledge was so swelled by sudden Rains, as to do much damage in Derby: Nov. 5, 1698, the Derwent was greatly flooded: also on the 21st of November, 1791*, when it carried away Toad-moor Bridge above Belper; on the 11th of February, 1795 †, the same bridge, and those at Watstanwell above it and Belper below it, were washed down; in the night of the 17th of August, 1799 ‡, the Derwent at Matlock Town rose rapidly, to a most surprising height: in February 1805 §, the Trent was unusually flooded.

The lower parts of the Derwent and the Trent are in some places *Embanked*, as will be further noticed in Sect. 2, of Chap. XIII.: and the Banks of the Rivers and Brooks have in some instances been sloped and improved, as will be mentioned in Sect. 1, of Chap. XII.

* The Register kept of the Rain at Chatsworth, on this River, of which I have given an account at page 99, in the Week preceding this Flood, was as follows, viz. on the 14th = ·173 inches, 15th = ·141, 16th = ·494, 17th = ·058, 18th = ·378, 19th = ·612, 20th = 2·062, and 21st = ·074, total of the week 3·992 inches.

† In the Week preceding this Flood, the Rain at Chatsworth was as follows, viz. on the 9th = ·274 inches, 10th = 1·184, and 11th = ·133, total 1·591 inches.

‡ The Rain of the previous Week was, on the 9th = ·541 inches, 10th = ·248, 11th = ·037, 13th = ·036, 15th = ·052, 16th = ·118, and 17th = 1·403, total 2·435 inches.

§ The Rain at Chatsworth in the first Week of this Month was, on the 4th = ·357 inches, 5th = ·500, and 8th = 901, total 1·758 inches.

In

In some of the Rocky Districts of Derbyshire, there are *Water-falls* or natural Cascades in the Brooks and Rivulets, in wet times, or falling into chasms or Water-swallows, as mentioned page 295; these I noticed, at

Alport Town, in the Lathkil, on Tufa and 1st Lime. See page 458.
Edale Chapel N, near Castleton (the Font), on 1st Grit.
Grindlow near Eyam, into Dowse-Hole, in 1st Lime.
Kinder N E, near Hayfield (Down-fall, or old-woman brewing), on 1st Grit, very high and romantic.
Lumsdale, NE of Matlock, on 1st Grit, high and romantic.
Monyash E, Ricklow Dale, on 1st Lime.
Over-Haddon S, in Lathkil, on 2nd Lime, see p. 475.
Peak-Forest S (Dam-dale), on 3rd Toadstone.
Phoside S, in Glossop, on 1st Grit.
Stoney-Middleton (Mill), on 1st Lime.

There is an artificial Cascade, constructed formerly at very considerable expense, on the SE side of Chatsworth House; one on the SW side of Lyme-Hall, near Disley, Cheshire; and another is shown to the visitors of Castleton, in Speedwell Mine.

I shall close this account of the *Rivers* in Derbyshire, by an alphabetical List, of those above enumerated, with the portion of Derbyshire, nearly, which each drains, viz.

	Acres.
Amber (except a part in Notts.)	31,000
Ashop	13,000
Bootle	8,000
Bradford and Lathkil	20,000
Dane (upper part)	580
Derwent (except a part in Yorkshire)	111,500
Dolee (except a part in Notts.)	15,000
Dove (only the E side)	81,000
Ecclesburn	15,000
Erewash (only the W side)	17,000
Ethrow (only the S side)	10,000
Goyte (only the E side)	31,000
Hipper	7,000
Idle (upper parts)	21,000
Mease (intermixed with Leicestershire)	16,000
Morledge	13,000
Noe	15,000
Nutbrook	10,000
Carried forward	435,080

Rother

	Acres.
Brought forward	435,080
Rother (upper parts)	45,000
Schoo	10,000
Sence (in Ravenstone)	2,000
Sheaf (upper part)	5,000
Shelf	10,000
Trent (middle parts)	70,000
Wye	45,000
Total of Derbyshire	622,080

[In my next I intend to follow up this subject, by extracting Mr. Farey's account of the more rocky and precipitous *Valleys*, &c.—EDITOR.]

XXIX. *On the Radiation of Cold.* *By a* CORRESPONDENT.

To Mr. Tilloch.

SIR, HAVING lately seen repeated at the Royal Institution, the experiment of the supposed radiation of cold; and being dissatisfied with the explanations commonly offered of this phænomenon, I am induced to trouble you with this communication, in order to learn whether an explanation which I have to offer, may appear to others more satisfactory than any of those usually given.

The experiment is too familiar to men of science to need description; I will just mention the explanation usually given, as I draw my conclusion from precisely the same premises, without attempting any new experiments.

Mr. Davy stated that heat constantly radiated from all bodies; and as the temperature of the thermometer placed in the focus of the one mirror is maintained by such radiation, if a piece of ice be placed in the focus of the other mirror, it displaces a portion of air which before assisted by its radiation (for he said that air did radiate heat) in maintaining that temperature: the thermometer therefore falls, but the ice being removed it again rises. Were this explanation the true one, it would follow, that when the thermometer is placed in the focus of the one mirror, although there be nothing but air in the opposite one, it ought to rise; otherwise it could not be depressed by the abstraction of that air, any more than by that of an equal quantity in any other spot at an equal distance.

But if it be true, that all bodies do constantly radiate heat,

heat, they do so as well at one degree of temperature as at another; and presuming that the heat so radiated must have the same temperature (if I may be allowed such a mode of expression) as the body from which it proceeds, it will follow, that the piece of ice will radiate heat which cannot have a higher temperature than 32° at the utmost; and this will of course instantly affect the thermometer, and even the hand of a person placed in the focus of the opposite mirror, as Mr. Davy stated that it did his: an effect inconceivable upon the idea that merely a small portion of warm air had been removed.

If a frigorific mixture was put into two vessels, one of which when filled with a heated substance radiated much heat, and the other the contrary; and if the thermometer was more depressed by the first being placed in the focus than the second, it might be considered as a decisive proof of the truth of this explanation, and the radiation of cold as it is called would be fully established: and indeed as no one now doubts that the only difference between heat and cold is a difference of temperature, and as it is known that one temperature is as readily communicated as the other, there seems no reason to be surprised that a body at 32° should radiate as well as one at 212°.

The important consequences that must follow from the establishment of this idea, in explaining many of the phænomena of nature, must appear so obvious to every one who has at all considered the subject, that I hope these suggestions may be thought worthy of consideration, as they may be readily either confirmed or refuted by those who have the necessary apparatus and assistance at their command, both of which are wanting to one who can consider himself in these matters merely as a looker-on.

March 1812. Z. Z.

*** Having the present opportunity, I shall, as others have ventured to do, offer what I conceive to be the true explanation of the phænomenon above alluded to. The facility with which radiation of temperature is effected, depends, in some degree, on the temperature of the body on which the radiation falls. If two bodies of equal temperature be placed in the focus of the two reflecting surfaces, it is evident that their radiant powers must be perfectly balanced. But let one of them be of a higher temperature than the other, then the body of lower temperature being in a capacity to receive an increase, it seems obvious that, being

being in the focus to which the other radiates, it must facilitate the escape of caloric from the other, by quickly absorbing all that is sent to it by radiation from that other body. In the common experiment the thermometer is the radiating body, and the ice the absorbent. A. T.

XXX. *A Sketch of the Natural History of the Cheshire Rock-Salt District. By* Henry Holland, *Esq. Honorary Member of the Geological Society* *.

The vast beds of fossil or rock-salt, which are found in different parts of the county of Chester, form undoubtedly the most important and peculiar feature in the mineralogy of this district. In offering to the notice of the Geological Society some remarks upon these mines, it may be proper to premise, that in a Survey of Cheshire, which I had the honour of drawing up for the Board of Agriculture, I entered at considerable length upon the subject of their natural history, and upon the manufacture of white salt from the brine springs to which they give rise. It will be my present object to consider more especially the mineralogical situation and characters of the Cheshire rock-salt; and though the repetition of some statements must necessarily occur; this, in the case of a work only partially known, can, I conceive, be attended with little disadvantage.

Character of the Country surrounding the Salt Mines.

In speaking of the general situation of the Cheshire salt mines, it will be proper to state some facts with respect to the nature of the surrounding country, that their mineralogical relations may more clearly be understood, and an opportunity given to speculate upon the probable origin of these important strata. The southern parts of Lancashire, the northern extremity of Shropshire, and the whole of the intervening county of Cheshire, form in conjunction one vast tract of plain country, interrupted by few elevations, and these inconsiderable in size and extent. The area of this plain may be regarded as extending nearly fifty miles from north to south, and as having an average breadth of twenty-five or thirty miles. Its eastern boundary, as more immediately regards the county of Chester, is a high range of sandstone hills, stretching from north to south along the borders of Derbyshire and Staffordshire; connected on

* From the Transactions of the Geological Society, vol. i.

the

the north with the hills in the West Riding of York, and on their eastern side passing into the limestone hills of Derbyshire. The sandstone, in a considerable part of this range, is slaty in its structure, and would seem to belong to the Independent Coal-formation of Werner, some pretty extensive beds of coal being found and worked under it. The southern boundary of the plain, which is the one approaching most nearly to the rock-salt, is irregularly formed by ridges of limestone and calcareous sandstone, leaving open some communications with the level country in the middle of Shropshire. To the west its limits are marked by the sandstone and limestone hills in the adjoining part of Wales, and by the sandy æstuaries of the Mersey and Dee.

The only ridge of hills, properly speaking, within the Cheshire plain, is one on the western side of the country, extending with a few interruptions from Frodsham to Malpas, and including in its progress from north to south, the high grounds of Delamere Forest, the Hill of Beeston, and the Peckforton Hills. This range, which no where attains an elevation of more than four or five hundred feet, is composed entirely of sandstone. A small quantity of copper ore has been found in the Peckforton Hills, which form its southern extremity. Another ridge of land, possessing a small and irregular elevation above the adjoining plain, may be traced from the hills on the eastern border of Cheshire, in a westerly or north-westerly direction to Halton and Runcorn. At this point, where it attains its greatest height, it is separated from the northern extremity of the former ridge, only by the intervention of the valley of the Weaver, which valley is here about two miles in width. Towards the eastern extremity of this range, we meet with a singular sandstone hill, called Alderley Edge, in which have been found ores of lead, copper and cobalt, and masses of sulphate of barytes.

This distribution of the high grounds in the Cheshire plain is traced out in the annexed map, and it will be seen, by a reference to this, that they form three distinct divisions of its area: one to the west of the higher sandstone range; another to the east of this, and south of the lower range; and a third lying north of the latter, and including the southern parts of Lancashire. With the exception of a very few instances only, the existence of the rock-salt appears to be exclusively confined to the southern or central plain.

The marl beds form the most peculiar feature in the alluvial strata of the Cheshire plain. These occur in great abundance in every part of the district; being found not only under the common soil, but occasionally, as on the borders of Delamere Forest, interposed between layers of sandstone rock. The Cheshire marls are also very frequently met with in large detached masses, twenty or thirty feet in thickness, in the working out of which, it is not unusual to find large assemblages of fragments of the older rocks. Portions of granite, often of large size, and showing on their surface evident marks of attrition, are among the most common appearances in these collections: no granitic rocks are found within fifty or sixty miles of this district.

The divisions which I have pointed out in the Cheshire plain are still further marked by the course of the streams in this tract of country. The Dee is the great river of the western plain; the Weaver and its subordinate streams receive all the waters of the southern division; while the Mersey and its tributaries do the same in the northern portion. From their local relation to the great beds of rock-salt, the streams of the southern or central plain possess a peculiar importance.

The Weaver rises in the Peckforton Hills, near the Shropshire border, runs for some miles towards the south-east, then making a sudden flexion to the north, continues in this direction, by Nantwich and Winsford, to Northwich, about thirty miles further. Here it takes a north-westerly course to Frodsham, where it expands into a sandy æstuary, connected with the channel of the Mersey. It receives its principal accessions at Northwich, where it is joined by the united streams of the Dane and Weelock from the south-east, and by a stream called Witton-Brook from the east. At Anderton, a little below Northwich, the valley, which has hitherto been comparatively wide and flat, is suddenly contracted by the approach of two ranges of high ground; that on the western side of the river connecting itself by a gradual rise with the heights of Delamere Forest; the opposite one passing by a series of irregular elevations into the range of high land, which separates the southern from the northern plain. At Frodsham the river flows, as I before mentioned, between the termination of this high ground and that of the ridge which crosses the county from north to south, the hills thus opposed corresponding perfectly in appearance and structure. We have

have thus two distinct contractions in the valley of the Weaver below Northwich; a circumstance in some degree worthy of notice.

Situation of the Brine Springs, Rock-Salt Mines, &c.

I have dwelt thus minutely upon local facts from their connection with the situation of the rock-salt, which, with few exceptions, has yet been ascertained to exist only in the valleys of the Weaver and its tributary streams; in some places manifesting its presence by springs impregnated with salt; in other places being known by mines actually carried down into the substance of the strata. A reference to the map will show the several situations where brine springs occur, or where mines have been sunk, in the course of these valleys. Between the source of the Weaver and Nantwich, it will be seen that many brine springs make their appearance; and in the latter part of this course, it would seem that brine might be obtained by sinking to some depth in any place near the banks of the Weaver. Proceeding down the stream, salt-springs occur again at Winsford, and in several situations between Winsford and Northwich. At Moulton, between these two places, a mine has been sunk into the body of rock-salt, and another also between Winsford and Middlewich. At Northwich the brine springs are very abundant, and here also many mines have been sunk for the purpose of working out the fossil salt. The springs occur again in several places further down the river, but none have been met with below Saltersford, about two miles from Northwich. At Whitley, however, two miles north of the Weaver, and six miles from Northwich, a body of rock-salt is stated to have been met with in boring for coal.

On the course of the river Wheelock, brine springs have been found at Lawton, Roughwood, Wheelock, and again at Middlewich, where this stream unites itself with the Dane. At Lawton a mine has been sunk into the rock-salt. In the valley of the Dane, no salt springs actually appear, but several circumstances indicate that brine has at some former period been discovered there, and this as high up the stream as the neighbourhood of Congleton. No springs have been found in the valley of Witton Brook, except at the part of it immediately adjoining the Weaver at Northwich.

The evidences of the presence of rock-salt occur, as I before stated, in very few places out of these valleys, and even

 some

some of the excepted instances appear to have a local relation to the southern or central plain. This is the case with the salt springs of Dirtwich, in the south-western angle of Cheshire; with a spring of very weak brine lately found at Adderley, in the northern extremity of Shropshire; and probably also with other saline springs which occur in the contiguous parts of Flint and Denbighshire. At Dunham, however, in the north of Cheshire, we find a weak spring, which cannot strictly be considered as connected with the formations of the southern plain. At Barton and Adlington, in the southern parts of Lancashire, brine springs likewise appear; and it is not improbable that other instances of the same kind may occur in the northern portion of the great plain. It appears possible, however, that these weak springs may derive their saline contents, not from distinct subjacent beds of the fossil salt, but merely from beds of clay or argillaceous stone, strongly impregnated with particles of the muriate of soda.

Manufacture of White Salt.

It would be foreign to the object of this paper to enter with minuteness into the natural history of the salt springs, or into the processes employed in the manufacture of white salt. Those members of the Society, who may wish for further information on these subjects, I beg leave to refer to the Survey of Cheshire before noticed. It may be sufficient here to state a few of the most general and important facts.

The brines met with in this district are very generally formed by the penetration of spring or rain waters to the upper surface of the rock-salt, in passing over which they acquire a degree of strength, modified by several circumstances, which it would be needless to detail. Their average strength, however, appears to be much greater than that of the springs met with in Hungary, Germany, or France. At Winsford, Northwich, Anderton, Lawton, Roughwood, Wheelock, and Middlewich, where all the principal salt works are situated, the brine springs contain between 25 and 26 per cent. of the pure muriate of soda; and in some of the springs at Anderton, the proportion stands as high as 26·566 per cent. a very near approach to the perfect saturation of the brine. The earthy salts held in solution together with the muriate of soda are principally muriate of magnesia and sulphate of lime; the quantity of these varying from $\frac{6}{10}$ per cent. to 2 or to $2\frac{1}{2}$ per cent. in different

ferent springs. The brine being pumped out of the pits, is first conveyed into large reservoirs, and afterwards drawn off as it is wanted, into evaporating pans, made of wrought iron. Here heat is applied in a degree determined by the nature of the salt intended to be manufactured, and various additions are made to the brine, with a view either to assist the crystallization of the muriate of soda, or to promote the separation of the earthy salts. The latter exist in a very small proportion in the manufactured salt, and cannot be supposed in any degree to affect the uses to which it is applied *. The importance of the Cheshire salt manufacture will be sufficiently obvious from the statement, that besides the salt made for home consumption, which annually amounts to more than 16,000 tons, the average of the quantity sent to Liverpool for exportation has not been less than 140,000 tons.

[To be continued.]

XXXI. *On the Nautical Ephemeris.*

To Mr. Tilloch.

Sir, A great deal having lately been written and said about the error in the Nautical Ephemeris for 1812, but very little towards assisting the public in correcting this trifling mistake, I flatter myself some of your readers will not be displeased at having an easy and expeditious mode of correcting the Sun's Declination as given in the Ephemeris; this being the part most affected by having assumed an erroneous apparent obliquity of the ecliptic in the calculation of that work.

The following small table of corrections I do not claim as my own; I found it in the *Connoissance des Tems* for 1812, where they also give the formula of its construction.

The correction is for every third degree of declination, and for one second of difference in the real and assumed obliquity of the ecliptic. All that is requisite to the application of the following table is to multiply the tabular number by the difference between the real and assumed obliquity.

The difference between the real obliquity and that assumed in the computation of the Ephemeris for 1812, is supposed to be about 8″ *too little*.

* In reference to the chemical character of the different varieties of salt, an excellent paper by my friend Dr. Henry will be found in the Philosophical Transactions for the year 1810, part i.

TABLE OF CORRECTION.

Declination	0°	3°	6°	9°	12°	15°	18°	21°	$23\frac{1}{2}$°
Correction.	0″·00	0″·12	0″·24	0″·36	0″·49	0″·62	0″·75	0″·88	1″·00

One example will make the whole intelligible to the meanest capacity.

Suppose it was required to correct the sun's declination as given in the Ephemeris when at 15°.

Under 15° you have 0″·62, being the correction for 1″ of difference.

As the error or difference is 8″ too little. Multiply } · 8″

4″·96 to be added to the declination as found in the Ephemeris, and this will be the true declination nearly.

Yours, &c.

March 3, 1812. H. F. P.

XXXII. *Substitute for a Repeating Watch.*

To Mr. Tilloch.

SIR, THE common watch, which is so extremely useful in the day, is of very little use in the dark. To remove this imperfection, a watch was invented which repeats the hour and quarters at any time of the day or night. Watches of this construction are exceedingly convenient, but they are too expensive for general use; and all other instruments contrived to answer the same purpose, that have come under my inspection, though less expensive are less convenient.

After many unsuccessful attempts to construct an instrument to supply the place of a repeating watch, at a small expense, and that might be equally useful, I found that a common watch with a very little alteration would answer the purpose perfectly well.

To make a common watch into a nocturnal one, I made notches with a file in the rim of its inner case, against every hour upon the dial, except 3, 6, 9, and 12. These tangible marks are made no deeper than just to receive the nail of the finger or thumb, as it is drawn over them. The hour of 12 is known by the pendant, and little pins are fixed into the case at the hours of 3, 6, and 9, projecting outwards about

about $\frac{1}{20}$ of an inch, to distinguish those hours from the rest.

To ascertain the time in the dark by this watch, nothing more is to be done, than to open the glass and feel with the finger the situation of the hour hand, and count the tangible marks, beginning at 3, 6, 9, or 12, to find the hour; and by the same means the minutes are found.

By a watch of this construction, the time may be ascertained in the dark to a much greater degree of precision than by a repeater, and without disturbing the repose of any person that may be near it.

I am, sir,

your obedient servant,

Lynn, March 21, 1812. E. WALKER.

XXXIII. *Notices respecting New Books.*

An Essay on the Probability of Sensation in Vegetables. By J. P. TUPPER, *F.L.S. and Member of the Royal College of Surgeons.* London: White and Co. Fleet-Street. pp. 142.

We have read this Essay with a degree of pleasure which induces us to make the Philosophical Magazine one of the organs of its publication. The work embraces a variety of subjects, on which the author has offered such observations, as evidently show that he is capable of thinking for himself. The language is simple, yet elegant and perspicuous, free from technical obscurity on the one hand, and affected embellishment on the other.

Mr. Tupper begins his Essay with the following introductory observations, to which he has prefixed a very appropriate quotation from Armstrong, as a motto—

"———— in a doubtful theme
Engaged, I wander through mysterious ways.

"It is as difficult to ascertain the nature of vegetable existence, as to determine what constitutes the living principle of animals. It is evident, however, that life is intimately connected with a particular organic structure of parts; for through the medium of that organization existence itself is preserved.

"The physiologist who investigates the laws which regulate and direct all the different movements of the animal machine, cannot observe without admiration its wonderful fabric, which, from a mere "*rudis indigestaque moles*," the secret working hand of Nature has elaborated into so complicate

plicate a form, every part of which is most exquisitely finished, and the whole so well and skilfully arranged, as to constitute a being capable of giving existence to others similar to itself.

"Although the vegetable physiologist may not have more to engage his attention, yet, he has not less to admire. How widely and wonderfully different is the mature vegetable from the seed which gave it being! How great the contrast between the diminutive acorn and the stately forest oak! The seed is seemingly nothing more than a mere homogeneous substance; but, when placed within the influence and operation of particular causes, its *latent* vital principle is called forth into action, a variety of organs are unfolded, and by successive evolutions the plant arrives at that state which constitutes the perfection of its nature, when, like animals, it is also endued with the power of propagating its species."

The Author then proceeds to consider "of the Distinctions between Animals and Vegetables," and next takes "a general view of their analogies," on which subject he points out many interesting particulars. After this, follow some observations on "Vegetable Motion" and on "Instinct and Volition," in the course of which Mr. T. has thrown out some very interesting and original ideas. The other subjects treated of are arranged in the following order: "Of vegetable Instinct.—Of the Sleep of Plants.—Of Sleep in general.—Of Sleep as related to the voluntary Power.—Of the locomotive Power.—Of Sensation in general.—Of vegetable Irritability.—Of the nervous System of Vegetables.—Of vegetable Sensation.—Objections considered.—Animals are exposed to Injuries.—Of the Limits prescribed by Nature to the Destruction of Life.—Of vegetable Self-preservation.—Organs of Defence in Vegetables.—Effluvia of Plants a Protection from external Injuries.—Of the Preservation of animal and vegetable Life.—Of the Enjoyment of Life.—Of the Limits between the animal and the vegetable Creation.—Conclusion."

The Author has also enlarged on some of the abovementioned subjects under the head of Additional Observations, which are chiefly of a metaphysical nature, and display much ingenuity of argument, although some of the opinions advanced may be open to dispute. On the subject of Instinct he concludes by observing,—"From this view of the subject we may form some idea how far instincts may supply any deficiency of intellectual power, and even compensate for the total want of reason in the brute creation.

But

But where shall we find any power, or quality, as a substitute for sensation? The idea of *instinct* is naturally associated with that of *life*, and the idea of both, either jointly, or separately, with that of *sensation;* and as sensation does exist in animals independently of those eminent attributes with which it is combined in our natures as rational agents, may we not reasonably infer that vegetables have likewise their share of sensitive power, and consequently the means of enjoying their own existence?"

Here the Author refers to some Additional Observations *on Sensation;* but as our limits will not allow us to make any further extracts from this interesting publication, we must beg leave to refer our readers to the work itself, and perhaps they will give to the Author a vote of thanks for the rational amusement which they may have enjoyed by the perusual.

XXXIV. *Proceedings of Learned Societies.*

ROYAL SOCIETY.

Feb. 27. Sir Joseph Banks, observing the motion of a snake (which had recently been sent to him) along the floor of his library, discovered that it was assisted in advancing by its ribs, which served the purpose of feet, the points of them touching the ground, and by those means facilitating its motion. The fact was made known to Mr. Home, who availed himself of the occasion to observe more minutely the peculiar construction of the ribs of snakes, and the manner they are adapted for this hitherto unobserved purpose of moving their bodies. The result of his examination was read in a short paper to the Society, stating the curious discovery of the President, and the accuracy of his observations.

March 5. A very long paper by Mr. Brodie was read, containing a minute detail of the author's additional experiments of the effects of various poisons on different animals. In one or two cases Mr. B. succeeded in recovering the animals by artificial respiration; but in the great majority of his experiments he failed. It appears that the slight inflammation which occurs in the stomach after taking poison into it is not sufficient to occasion death, but that it is the palsying power of the drugs on the nervous system and on the blood, which destroys life. Some poisons in this respect are much more destructive than others; but the

the author did not in any of his numerous experiments try the antidotal powers of oxygen on the system.

March 12. A paper by Dr. Herschel on the second comet was read. This astronomer has been equally occupied with what he calls the second comet, as with that of 1811: he considers the latter, which, although much nearer the earth, is almost invisible by the naked eye, as much older than the former; that it has experienced as little alteration in its perihelion passage as our earth; that it is opaque, destitute of any phosphoric lumination, and shines with a borrowed light, contrary to that of last year. This circumstance he inferred, as it is visible only through glasses of low magnifying powers, being seen distinct with a magnifier of 150 or 160, but quite confused with one of 170 times, whereas the former was seen perfectly with a glass magnifying 700 times. The diameter of its nucleus he estimates at 2637 miles; its *chevelure* extends over upwards of six millions of miles. According to the author's theory of comets, by the condensation of nebulæ, he imagines the present to be much more condensed and perfect than the preceding one, and looks forward to its attaining all the other characters of a habitable planet.

March 19. A paper by Dr. Henry of Manchester, illustrative of a former paper by this chemist on oxymuriatic gas, was read. He decomposed by electricity muriatic acid gas into hydrogen and oxymuriatic gas, and produced water by electrizing muriatic acid gas mixed with oxygen. He considered his experiments on the whole as favourable to professor Davy's theory, but did not attempt to decide positively on the subject. He observed, however, that the greater number of facts seemed to favour Mr. Davy's views.

Two mathematical papers by Mr. Knight were communicated to the Society through the medium of Mr. Davy. They were of a nature not to be read, but of considerable length, accompanied with tables and diagrams illustrating the attraction of planes. The Society then adjourned over two Thursdays, on account of the holidays, till the 9th of April.

ROYAL INSTITUTION.

Mr. Davy's Lectures on the Elements of Chemical Philosophy.

Mr. Davy's sixth lecture was delivered on Saturday, the 29th of February. It related to radiant or ethereal substances,

stances, those forms of matter which are known only in motion, and by their effects, and which cannot be weighed or measured. The well known agencies of radiant matter are of three kinds—1st, those agencies which produce vision—2d, those which occasion heat—and 3d, those which occasion chemical changes. If a beam from the sun, said he, be passed through a prism, it is separated into rays which produce different colours, such as red, orange, yellow, green, blue, and violet; and into rays which produce heat, and rays which occasion particular chemical effects: the invisible rays which produce heat, are *more* refrangible, and those which occasion chemical changes, *less* refrangible, than the coloured rays. Rays that produce heat and light, and probably chemical effects, are disengaged in the combustion of bodies; and rays that produce heat, seem to be constantly emitted by bodies at the surface of the earth, but in quantities smaller as their temperatures are low. Mr. Davy exhibited an experiment in which gunpowder was fired in the focus of a mirror placed at ten or twelve feet from a small pan of charcoal;—and another experiment in which there was an apparent radiation of cold from ice, but which he explained by stating, that ice radiated less heat than the air which it displaced. Metallic vessels, he said, as Mr. Leslie had shown, radiate less heat than porcelain or glass vessels, and hence they are more fitted for preserving liquids or meats hot; pipes for heating rooms, he said, should be polished, where they are intended to retain heat, and covered with black paint or varnish where they are intended to give it off. He referred to the analogy between the powers of radiant matter and electrified bodies: the most refrangible rays in the coloured spectrum are analogous in their powers to those of positive electricity; the least refrangible rays to those of negative electricity. Mr. Davy seemed inclined to adopt, in preference to all other views respecting radiant matter, those of Newton. This great man supposed them to be particles emitted from bodies having certain figures possessed of attractions and repulsions. But, said Mr. Davy, we are still in the infancy of this branch of science, which promises in its extension to connect together mechanical and chemical philosophy, and to afford simple and sublime principles to this part of science. The agencies exerted by radiant matter, said Mr. Davy, produce a number of important effects in Nature, and, by their relations to vision, give as it were a language to the external world:—without this effect, said he, we should be limited to our own globe; but by its means we

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are incited to raise our thoughts to the great scheme of the universe, to pass from our transient and temporary existence, to laws which appear eternal in their operation—to recognise one order in the immensity of space—and to indulge hopes, that in the future progression of our being, we shall behold fully that magnificent system, which we now see darkly and at a distance.

Mr. Davy delivered his seventh lecture on Saturday the 7th instant. The ideas of the ancients concerning the elements of matter were founded upon superficial observation of the great forms of Nature, and were rather poetical than philosophical. Water, air, earth and fire were supposed to be unalterable: principle, or matter, was considered as constituted by solid, indestructible atoms, as in the school of Epicurus; or by regular solids, as among the Pythagorean philosophers. The alchemists considered the rude results of their operations by fire, as the principles of things; salts, oils, phlegm, and sulphurs were the elements which they imagined. All these ideas are discarded by modern chemists, who do not pretend to define what bodies are really unchangeable, or the true elements in nature, and speak of compound and simple bodies merely in relation to their own knowledge. The methods by which chemical truths are gained, are analytical or synthetical; by analysis bodies are resolved into simpler forms of matter; by synthesis they are composed from their constituents; and the test of the accuracy of the process is the correspondence in weight between the compound and its constituents. By the application of weight and measure to chemistry, says Mr. Davy, its results are rendered certain and unchangeable, and independent of any alterations of theory—and it is placed, like astronomy, within the province of the science of numbers and quantity. Mr. Davy divided the substances not yet decompounded, into two great classes—supporters of combustion and inflammable bodies. In the first class, he said, there were only two substances as yet known—oxygen and chlorine. He devoted the remainder of the lecture to the demonstration of the properties of the former. The gas forms one-fifth of the air of the atmosphere, and is the principal necessary for combustion and respiration. In its pure form it produces a number of brilliant results, by acting upon inflammable bodies; the metals burn in it brilliantly and absorb it, and it is a constituent part of most acids and alkalies. Mr. Davy showed a beautiful experiment, in which the same oxygen, by being combined with sulphur, formed an acid, and by being abstracted

tracted from the sulphur by potassium, which took place with vivid combustion, formed an alkali. Mr. Davy entered into some general views respecting the manner in which the oxygen of the atmosphere, and that dissolved in water, were renovated. Oxygen is absorbed, and carbonic acid is produced, in the respirations of animals, in combustion, and in fermentation; vegetables in the sunshine absorb carbonic acid and evolve oxygen. Mr. Davy combated the idea that this function of vegetable life was not sufficient to supply oxygen equivalent to that consumed. There is no other mode known in which carbonic acid is decomposed in the processes of nature; and did not vegetables absorb it, it must be constantly accumulating; which is known not to be the case. A great part of the solid surface of the globe is covered with plants, and light is essential to their healthy growth; and therefore great quantities of oxygen are produced in countries where there is little animal life. Fishes, he stated, will live in confined portions of water containing aquatic plants, and the oxygen they absorb is compensated for by the plants, which decompose the carbonic acid afforded in their respiration. This view of the connection of plants and animals in their action upon air, is not only supported by many proofs, but is likewise, says Mr. Davy, conformable to the analogy of nature;—it proves to us that the meanest weed, the most poisonous plant, is not without its uses in the œconomy of things—the different parts of the atmosphere are mingled by winds—the carbonic acid not consumed by sound plants is carried into the waters, dissolved by rain, mists, and dews—the sea is kept in agitation by waves and tides, and its influence upon the air constantly exerted—the storm and the whirlwind assist in this beneficent ministration; and the harmony displayed in such diversified combinations offers a striking instance of the wisdom and perfection of the arrangements connected with the preservation of life in the system of the globe.

The eighth lecture of Mr. Davy was delivered on Saturday, March 14; it was devoted to the consideration of the nature, properties, combinations, and uses of chlorine, or oxymuriatic gas. Some experiments were also made on enchlorine, a gas recently discovered by the Professor.

The illustrious Scheele discovered chlorine in 1774, and he considered it as an undecompounded body. Soon after Lavoisier and Berthollet regarded it as a compound of muriatic acid gas and oxygen, and their views were embraced by all the chemists in Europe; and during a period of 30 years

years no doctrines in chemistry were considered as more happily elucidated, or more clearly established.

Mr. Davy, after a rigid examination of the evidences on which the opinions of the French chemists were founded, was compelled to reject them as false; and the new theory he has advanced, relative to the nature of chlorine and muriatic acid gas, has been generally embraced, though some chemists in France and Scotland still adhere to the old exploded doctrines.

The Professor illustrated his views by simple statements of facts and experiments. Water is formed from the union of oxygen and hydrogen. When hydrogen and chlorine are detonated together, according to M. Berthollet, a compound of muriatic acid and water should be the result; but when proper precautions are taken, muriatic acid gas only is formed. Again, when any of the metals, as potassium, zinc, tin, &c. are heated in muriatic acid gas, hydrogen gas is evolved, and compounds are formed precisely similar to those obtained by heating these metals in chlorine. By these simple experiments, and others of a similar kind, the great problem concerning the nature of muriatic acid gas is happily solved.

Mr. Davy regards chlorine as an undecompounded principle analogous to oxygen; like oxygen, it is highly negative, and becomes an acid by combining with inflammable matter. By no known methods can it be resolved into simpler principles.

Mr. Davy exhibited an experiment in which charcoal was ignited in chlorine by Voltaic electricity, but it remained unchanged. Oxygen can in no instance be obtained from any of the combinations of chlorine, but through the medium of water, or compounds containing oxygen; and most of the erroneous views and reasonings on the subject appear to depend on the presence and decomposition of water. Thus, when the compounds of phosphorus and chlorine, and sulphur and chlorine, are mixed with water, the acids of phosphorus and sulphur, and the marine acid, are presently formed.

Chlorine has a stronger attraction for certain substances than oxygen. This is exhibited in the case of copper, tin, &c. which in combining with chlorine produce vivid combustion. It is also shown in the facility with which chlorine disengages oxygen from the metals of the fixed alkalies and earths.

The fixed alkalies, and earthy salts, known by the name of muriates, are in fact compounds of chlorine and metallic bases.

Mr. Davy

Mr. Davy developed some new views relative to the theory of bleaching. Berthollet, who first applied chlorine to this process, supposed that chlorine destroyed colours by losing its oxygen. Mr. Davy ascertained that the oxygen, which appears to be the true bleaching principle, is furnished by the decomposition of the water present. Chlorine dissolved in water cannot be employed in bleaching without injuring the texture of the cloth, in consequence of the formation of muriatic acid in the process. A compound of chlorine and lime is commonly employed in bleaching, but even this injures the fabric of the linen. Mr. Davy has found that a compound of chlorine and magnesia bleaches without affecting the vegetable fibres, and on his suggestion it has been used with success by some manufacturers in Ireland.

Chlorine combines with oxygen, and forms enchlorine. Some beautiful experiments were exhibited, illustrating the properties of this gas. When gently heated it was decomposed with explosion, and its fine yellow colour entirely destroyed. The metals, which readily burn in chlorine, are not affected in this gas; but at the moment of its decomposition by heat, they burn vividly.

The combinations of chlorine and hydrogen, and chlorine and oxygen, harmonize with the doctrine of definite proportions.

These new views respecting chlorine prove the necessity of attending to minute experiments, and the danger of forming hasty generalizations. The ideas adopted on this subject by the French School of Chemistry are entirely gratuitous: every thing was taken for granted, nothing proved. By using statical methods, the new truths are firmly established, and improvements in theory immediately lead to improvements in the œconomical applications of Science to the purposes of the Arts.

LONDON PHILOSOPHICAL SOCIETY.

This Society has been favoured with four excellent lectures upon the Anatomy of Oratorical Expression, by Mr. Wright, and which have engaged their meetings for the last month. We shall endeavour to give a concise though correct outline of them.

The learned author commenced his papers by observing, that sensitive and intellectual endowments form the basis of oratorical excellence; and that good understanding and solid thought, happily blended, combine all that is useful in the character of either senator, pleader, or divine.

To prove the solidity of judgement and the rectitude of

 sentiment

sentiment by which the minds of Englishmen are so eminently characterized, Mr. W. alluded to the celebrated controversies of Lord Chatham and Sir William Pulteney, the disputations of Mr. Pitt and Mr. Fox, the metaphysical disquisitions of Mr. Windham, the splendid talents of the "silver-tongued Murray," the transcendent abilities of the author of the "Sublime and Beautiful," the characteristic circumflexes of the inhabitants of Scotland and Ireland, all of which fully exemplify their quickness of thought and readiness of discernment.

Having considered the rise of the liberal arts as dependent upon the science of oratory, and demonstrating its excellence in Great Britain, he proceeded to treat of those particular circumstances calculated to call forth the genius of an orator. "It has been urged," says he, "that the genius of an orator cannot appear in all the fullness of its vigour, unless it be assisted by the concurrence of congenial and appropriate causes, by the fitness and plenitude of time, circumstance, and place. Regard the tumults of Greece, say they, and contemplate the discords of Rome! It was this which stimulated the exertions of a Cicero: this which fired the breast of a Demosthenes—"Let us march against Philip!" It was this which "call'd aloud on Tully's name and shook the crimson'd steel!" that vociferated the cause of Freedom, Liberty, and Rome! Contingences like these might have exhibited a Demosthenes or a Cicero; but "let me ask," says Mr. W. "these bold declaimers, whether similar chances operated on a Saul of Tarsus?" To pass over the advantage of an opportunity which the ancients did not possess, to leave for the present our sublimer notions of astronomy as dictated by Sir Isaac Newton, the discoveries in chemistry by Priestley, Lavoisier, Davy, and others, to disregard other modern discoveries, (all of which are well calculated to improve the moral feeling, and to extend our general view of objects and things,) let us contest the science and ability of our constitutional assemblies, our houses of parliament, and courts of judicature.

After copiously treating of the rise and fall of eloquence, in a manner which we should feel pleasure in following, did not the narrow limits of a journal prevent, the lecturer proceeded to investigate genius and qualification. "A habit of close thinking," says he, "has ever been acknowledged to be peculiar to the inhabitants of the British isles; and their standard language appears to be appropriate to their energy of mind." "*Quelle langue raisonnée!*" Now, if we compare this evident disposition of the

the mind of Britons with the strength and judgement of the Greeks and Latins, as philosophers, they cannot be conceived inferior; and if we proceed further to consider the premeditated examples of the oratory of the latter, and the off-hand extemporaneous specimens of the former in their senate and courts of law, as disputants and metaphysicians, let us see whether the modern Britons appear far behind the Grecians or Romans?

To proceed: In those remote ages, to be enabled to discourse for six, eight, or ten hours, or for a whole day, was regarded as something worthy of the highest admiration! An orator, then, (to use the language of one of Quinctilian's orators in his celebrated dialogue,) comprised a tedious introduction, circumstantial narrative, division upon division, and subdivision upon subdivision. All this was certainly wonderful, for it argues that they must have been physically powerful as well as mentally strong; and also, that the people must have been very fond of hearing long specimens of premeditated oratory. But this extreme enthusiasm, as well as their excessive fondness for the drama, when kings and princes descended from their sacred offices to personify on the stage, evidently prove depravity of taste, rather than accuracy of discernment. On the other hand, when we are given to understand that the tedious harangue of Demosthenes against his guardians served only to prove his insufficiency, and likewise that the egotized specimens of Cicero in the former part of his practice did not assist to establish his character, we give the ancients credit for their judgement.—With us it is very different; and what Quinctilian insinuates concerning the orators of his day, seems to apply in a most pointed manner in favour of our senatorial and legislative orators. "The auditory prescribes the limits of the orator's speech; it will not wait calmly until *he* pleases to return to the point; but it *openly calls upon* him, and *testifies its impatience*, whenever he seems disposed to wander from the question."

After endeavouring to prove the progress towards perfection of this valuable attainment among the Britons, with a minuteness which does him great credit, he proceeded to recommend the application of logic and the whole circle of science, with the study of rhetoric in our schools of eloquence; without which, our orators will ever be as dry, sour, and morose, as the declining Romans, unassisted by law and philosophy, were whining, mawkish, and insipid. Mr. W. then decided in favour of the modern Britons as

 disputants

disputants and metaphysicians, and of the Greeks and Romans as excelling in the art of rhetoric.

Having considered the efficacy of graceful and energetic delivery, by which the ancients were enabled to carry the art of oratory to unrivalled perfection, of which Cicero and Demosthenes are striking examples, the learned lecturer proceeded to state, that being enabled by the exercise of the understanding, the will and the memory, to appreciate the whole circle of science, such a one would readily invent suitable arguments, and dispose them in their proper order; and while he remembered every bearing of the question, he could arrange, modify and round, variously every period, and so deliver the whole with order, contrast and nature. The accomplished orator will avoid every extreme; and while he alternately moves the passions and convinces the understanding, through the medium of the moral sense, he will finally succeed in arresting the attention, inspiring the mind, exciting the whole man, and impelling him irresistibly to action.

Further: To command attention, the orator must participate in the feelings of all around him; in a word he must flatter the senses of his auditory: that once accomplished, contending or opposite opinions will be rendered more susceptible to receive impressions of improvement; and however modified by affection or passion, or from other causes, however the appearance of right and wrong may be altered to the intellectual faculty, the love of truth is firmly implanted in the breast of every individual; and consequently the mind of man, if judiciously assailed, *must be open* to the entire conviction of reason. The author then spoke of elocution, and its utility in arresting attention. In consequence of the perverted plan of conveying instruction in this branch of education, he conceived, many of the finest specimens of argumentative writing, many of the sublimest arrangements of composition, finely interwoven with sentiments of penetration and feeling, to pass by unheeded from negligent enunciation and delivery: after which he submitted an analysis of vocal sounds, proving the human voice susceptible of five modifications; the two inflexions, the two circumflexes, and the monotone; endeavouring also to prove, that when the mind is tranquil, the compass of inflected and circumflected accentuation accords exactly with musical phænomena, forming the substructure of "The Philosophy of Elocution."

With

With this he concluded the first lecture, which had particularly for its object, to prove that in Britain there is free scope to exercise oratoric genius, and that Britons are endowed with every qualification requisite to form complete orators.

Mr. Wright commenced his second lecture, by an inquiry into the instinct voices of animals, which he considered as not analogous to language; proceeding from thence to treat of sensation. "All our sensations," says he, "are either *pleasing* or *painful*; and doubtless all the passions, emotions, and sentiments, which can possibly agitate the mind of man, are comprised in the two following, *love* and *hatred*."

Now if we observe the correspondent tones, which uniformly accompany the expression of any particular modification or feeling of the human mind, we shall perceive them to be commensurate to our general idea of *concord* or *discord*. When the felicity of mind is diminished by the presence or recollection of painful sensation, man is empowered to communicate his feelings by characteristic signs of dissonance; and the diversified tones and pauses which usually accompany the expression of an agitated mind, naturally suggest the varied state of muscular exertion: but when emotions are excited by the impression of objects which calm and delight the imagination, in communicating such feeling, the expression of sound, being regulated by consonance of vibration, dwells upon the ear with pleasure and satisfaction.

Continuing these arguments in an elaborate manner, and advancing well chosen examples to illustrate them, Mr. W. made the following deduction: "that orators, speakers, and readers, who do not display apposite expression of earnestness and feeling in their several themes, discourses, and specimens, must either not be impressed with the truth of what they are advancing, or be ill favoured by nature with the usual powers of organic association; and that they are liable not only to have their arguments confuted, but also to have their characters branded with insincerity, vice, and falsehood."

Having ably delineated the character of an orator, and having endeavoured to show, that when the organs of the external senses were naturally insusceptible to the various impressions of objects, or when the elastic fibres of the body were relaxed by partial or general debility in the constitution, the mind could not easily be taught sympathy and social affection,—he advanced to another bearing of the question, seeming to imply, that an individual may be ori-

ginally endowed with mental feeling, yet from various causes which bring on lassitude in the muscular fibres, he may be incapacitated to summon up suitable powers of expression at will.

There are few individuals who have not experienced disappointment in some shape or other. If therefore we reflect on the inaptitude of will or mind, which, by some sudden stroke of chance, has been apparently placed far beyond our reach, and if also we take into consideration the powerful stimulus which is necessary in such instances to give us just notions of the hope which remains of still accomplishing our desires, we shall then have some idea of the consequent laxity in the muscular fibres.

The next point which engaged attention was that most essential part of the character of an orator,—modesty. "Without modesty," says Tully, "there never was a good orator." After citing Cicero's observations respecting himself, and adverting particularly to the Greek orators upon this subject, Mr. W. asserted, that an orator should be esteemed as perfectly true in his intentions towards his audience, and that he should be known to have a warm sense of general feeling and affection for his fellow-creatures; proving an unimpeachable character to be a qualification of all others the most essential for the preferment of a public speaker; and that truth, integrity, and earnestness, are inseparably united with the art of persuasion. This lecture was concluded by a view of the inconsistency of man, and his consequent proneness to judge of the appearance of persons and things that he may suit his own temper and disposition.

The third lecture commenced with some observations on the philosophy of feeling, comprising affection, passion, emotion, and sentiment; previous to considering the outward attributes of expression. On this head we select the following passage: "In contemplating the philosophy of feeling, I cannot but be astonished," says Mr. W., "that writers on oratorical expression have not presented us with more accurate definitions of the passions. Excepting one or two, all the volumes which have been handed down to us on the science, do not in this particular exemplify either regularity, principle, or theory."

"In the middle of the last century, the lecturer of oratory on the foundation of Erasmus Smith, esq. in Dublin, seemed to enter fully into these ideas, when he endeavoured to unravel perplexities which modern metaphysicians had then thrown upon the performances of the ancients: And if

if I am not," continues Mr. W., "insufficiently read in the present subject, Dr. Lawson was the first of the modern professors of rhetoric, who endeavoured to systematize the passions for the use of students in oratory. But while this tribute of attention is offered to the memory of the lecturer of Trinity College, and to the exception of every other lecturer of the science, we are not to enter into the ideas implied in the apology of the doctor at the conclusion of the ninth lecture, expressly intimating, not only that rhetoricians had defined the passions imperfectly, but that moralists had fallen into similar negligences; that his ideas on the subject were completely new; and, as such, the theory would be considered an innovation, and so be liable to censure. Now this was evidently to the exclusion of the disquisitions contained in the voluminous treatises of Dr. Hutcheson on the Passions; the best perhaps extant: books which had been published only a few years before, and which caused controversy sufficient to produce illustrations of the moral sense, and which Dr. Lawson might possibly have perused; books which prove to us, that there can be no exciting reason previous to affection, instinct, or the moral faculty; and that the conscience is distinct from the sense of moral good and evil; and so that we may discover, that what taste is to natural discernment, conscience is to the moral sense, improved by knowledge and care."

In pursuance of the inquiry, it may be curious perhaps to observe, that although Walker and Sheridan have descanted with considerable feeling and energy on this branch of the science, yet neither the one nor the other has satisfied the various inquiries of philosophical and interrogating students. In his essay on the Passions, Mr. Walker has adopted the method of Mr. Sheridan,—calling the true signs of the passions, 1st tones, 2d looks and gestures. And although the master of inflection had most certainly the ability to analyse the former, and to dwell with considerable advantage on the latter, he consigns *without* definition, and leaves the student, who *feels* himself deficient, to turn his studies to some other department of learning, where nature may have been more favourable to his wishes. The other lecturer exerted every energy within his power; but unfortunately his judgement was deficient, and his will in consequence was inadequately directed. Perhaps it is the circumstance of having submitted imperfect ideas or definitions of the speaking voice, which has rendered the works of Mr. T. Sheridan so totally useless to students in elocution. We must not feel surprised then, that the author of British Elocution proceeded

no further in analysation than his lectures manifest, when he admitted not the existence of inflexion, or that termination to which all speaking sounds may be resolved. But independently of inflexion, the ideas of Mr. Sheridan on tone are insufficient. When speaking of the Chinese language "being chiefly made up of tones," and when proceeding further in exemplification, observing that the same individual word has "sixty different meanings," according to the different tones in which it is pronounced; he appears to jumble together qualities totally heterogeneal,—such as tune and tone, tune and accent, sound and articulation. Now tune refers to variety, harmony, and cadence; tone to quality of sound, whether high or low, the natural or feigned voice. The lady sings chastely (*i. e.* scientifically and in tune), but she wants voice (*i. e.* tone and compass.) Accent implies stress variously delivered, *i. e.* either in an upward or downward slide of voice; or, after the term accent of the Greeks, we may distinguish it by the names of acute, grave, or circumflex. That gentleman has either the Scotch or Irish accent in his pronunciation, *i. e.* circumflex. Articulation is sound modified by the various organs of speech. The whole alphabet may be pronounced or articulated in one note of music, or, in other words, one musical sound; and *vice versâ*, the whole compass of the voice may be exemplified in one articulation; so that we can perceive, when Mr. Sheridan speaks of tone and the tone of passion, he leaves the word just as he found it, and very *gravely* informs the student, that tone is—tone. In the analysation of speaking sounds Mr. Walker proceeded further than the other gentleman, and we feel the more regret that he did not adapt his inflexions to the expression of passion and the progress and completion of sense.

Mr. W. then advanced a great number of arguments, tending to prove, in the most direct manner, that Nature has endowed man with an intuitive power of conveying feelings of love or hatred, by signs of consonance or dissonance; which concluded the lecture.

The fourth and last lecture consisted chiefly of illustrations of the different passions, mostly selected from our immortal bard, and which were admirably delivered by the ingenious lecturer, producing their proper effect: and also of a vindication of Aaron Hill's Treatise on Expression, as founded upon one general principle of reason and philosophy. We agree with Mr. W. in imagining, that great advantage might possibly arise from a well regulated theory of the passions, should every admirer of the science apply himself to that branch of eloquence with unremitted observation

servation and active industry: for, without an expressive display of feeling, the orator is, at best, but lifeless marble. From the writings of the ancients, we must suppose them to have been complete masters of expression. They appear to have felt themselves impressed with just notions of the assistance afforded to their specimens, by duly appreciating and considering the passions as the secret springs of all the actions of man.

In conclusion, we think great praise is due to Mr. Wright for his ingenious lectures, and from whose indefatigability in this department of science many more highly instructive lessons may be justly anticipated.

RUSSELL INSTITUTION.

Geology.

On February 24th Mr. Robert Bakewell commenced a course of lectures on the natural history of the earth, and its mineral productions, designed to illustrate the Geology and Mineralogy of England. In the first lecture, after adverting to the present state of geological science, Mr. Bakewell observed, that it might be considered in its infancy, compared with the progress which other sciences had made during the last 300 years; nor had it attracted much attention from landed proprietors who were most interested in its advancement, their knowledge of the rocks, strata, or minerals on their own estates being in few instances greater than that of their ancestors in the ruder periods of our history. All the substances now considered as simple, found in the mineral kingdom, do not exceed fifty: with nearly one half of these, Mr. Bakewell stated, we had only been made acquainted during the last twenty or thirty years; a fact which was itself alone sufficient to mark the infancy of the science.

The form, magnitude, and density of the earth, and its revolution on its axis, are the first objects of inquiry in the natural history of our planet, connected with its internal structure. The experiments and observations of Dr. Maskelyne and Mr. Cavendish, relative to the density of the earth, Mr. Bakewell observed, differed considerably in their results. From the recent corrections of professor Playfair, who had ascertained the specific gravity of the stones forming the mountain Shehallion on which Dr. Maskelyne's observations had been made, it appeared that the density of the earth, or the quantity of matter it contained, is nearly five times that of an equal bulk of water. From hence Mr.

Mr. Bakewell said it might be inferred that the earth is nearly a solid ball, or, if it have extensive cavities, the solid parts are heavier than most metallic substances, and probably contain a very large portion of iron. The opinion which has been lately advanced, that the different earths and alkalies exist in a metallic state in the interior of our planet, and inflame when water finds access to them, was, he conceived, ingenious, but unsupported by much probability.

The division of rocks into primary, intermediate or transition rocks, and secondary, though liable to some objections, Mr. B. said he should follow in the present course, as such an arrangement enabled us to fix more distinctly the different parts of the subject in the memory.

Each of these divisions he said would be described in the future lectures, and he traced on a geological map of England, drawn for the purpose, the different parts of our island which they occupy. On the eastern side this division is more distinctly marked; but on the western side the strata are much fractured and intermixed by some unknown cause, which had elevated them in some situations and depressed them in others, and made it difficult to trace their continuity or connexion. According to this division, there is a considerable part of the eastern side of our island in which no coal is found, and a still larger division which he traced where no metallic ores exist. Mr. Bakewell said that, so far as he knew, this was the first attempt to represent in a map the geological outlines of England.

After explaining the different theories of the earth, by diagrams and descriptions, Mr. Bakewell observed, that they were only entitled to consideration so far as they appealed to facts for their support, and every impartial observer of nature must have seen appearances which cannot be explained satisfactorily by any of the systems hitherto advanced. The great changes which the surface of our planet has undergone in remote ages, are confirmed by proofs equally intelligible and impressive, though we are unacquainted with the means by which such changes have been effected. Rocks composed of shells and remains of marine animals form the summits of some of the highest mountains of Craven in Yorkshire, in Derbyshire, and in different parts of the world. The height at which these are found in Yorkshire is 2400 feet above the present level of the sea, but on the Pyrenees they are found at the height of 10,000 feet. The impressions of marine animals in slate rocks present appearances still more curious and difficult to explain.

explain. Marine remains are also found imbedded in rocks at the greatest depths which have been explored. No remains of man have been found in solid rock, except in mines, or what had been covered by recent depositions of calcareous earth ; of which specimens were shown. The skeletons of quadrupeds found in mines and cavities of calcareous rock, he considered as recent, compared with the marine remains of which such rocks were composed. The entire skeleton of an elephant was found in a mine near Wirksworth. Mr. Bakewell supposed that, in this instance, a cave, once open to the day, had been closed by stalactitical formations ; which is frequently the case. From these fossil remains in the mineral kingdom, Mr. Bakewell said it might be inferred, that the creation of man was posterior to that of other animals, and took place long after those mighty convulsions which elevated part of our present lands and continents from the bottom of the ocean.

Second Lecture.—Mr. Bakewell described the qualities of the four earths, silex, clay, lime and magnesia, which, with the oxide or rust of iron, compose all the great masses of matter found on the surface of our globe. In some instances they are combined with the sulphuric or carbonic acids. These few elements entering into combinations with each other, constitute the great variety of stones found in the mineral kingdom ; and it was not difficult for a person entering on the study of mineralogy to ascertain the earths whose qualities were most predominant in each kind of rock. The rocks called primary contain no organic remains, they are chiefly composed of siliceous earth (except primitive limestone), they are generally hard and crystalline. Of these the most important is granite, being considered by many geologists as the foundation rock on which all the others are laid. Next to granite are usually found the different slate rocks, known by the names of gneiss, and micaceous and argillaceous schist : of these specimens were exhibited, and their nature and localities described. Mr. Bakewell, in stating the different parts of England and Wales where the primary rocks appear, said, it had been erroneously asserted that there are no granite rocks in Cumberland and Westmoreland ; on the contrary, there are in both these counties, rocks of highly crystalline large-grained granite, of which he produced specimens. Most of the other rocks called primary, generally exist in beds of different depths amongst the slate rocks, or cover them in vast masses, and which appear to have been of more recent formation.

The arrangement of rocks in the primary mountains of Great

Great Britain, and different parts of Europe and America, were explained by drawings and sections. The highest point at which granite is found in Europe is 15,000 feet; in South America granite has not been observed higher than 11,000 feet; but in that country the granite and slate rocks are covered with immense beds of porphyry and basalt, which Mr. Bakewell said he was inclined to believe were the products of subterranean fires. The rocks that lie next to the primary have been called transition rocks, from a fanciful supposition that they were formed when the earth was passing from an uninhabitable to a habitable state. These principally consist of particular lime rocks, and a rock called by the Germans grauwacke, which is a kind of coarse slate intermixed with fragments of other rocks. These lime rocks form entire mountains in Yorkshire, Derbyshire, and part of North Wales. Mr. Farey, in his late survey of Derbyshire, has described the undermost limestone of that county as the lowest rock in England; but Mr. Bakewell observed, that the same limestone which dips under the surface in the northern part of Derbyshire rises up again in the north-west of Yorkshire, and is there found to rest upon slate. In Shropshire and Wales similar limestone with similar metallic veins also rests upon slate, and this slate in all probability rests upon granitic rocks, though the granite is not sufficiently elevated to be seen, except on the western verge of England and Wales. The primary and first order of secondary rocks are the repositories of metallic ores. In the lime rocks of this class the most extensive caverns are found, some of which were described with sections, explaining their formation by subterranean currents. Mr. Bakewell stated the influence of elevated mountains on the temperature of the adjacent countries, which, he observed, might in some degree be measured by the period at which snow disappears from their summits. In some few instances, he said, snow had continued the whole year on the summit of Crossfell in Cumberland. The influence of mountain scenery even over the untutored mind was in many nations almost indelible, and created a strength of local attachment which was not known to exist in the inhabitants of flat and more fertile districts. The lecturer particularly recommended to the opulent inhabitants of large cities, an occasional residence among the mountains; where he observed they might contemplate the grand features of creation, and revive their taste for the sublime beauties of nature; and from whence they could scarcely fail to return with invigorated health, and with a certain

certain freshness of mind which would enable them to discharge with greater alacrity the duties of active and social life.

GEOLOGICAL SOCIETY.

March 6.—Sir George Clerk, Bart. M.P. was elected an ordinary member of the Society: and several presents of books were announced.

An additional notice by Arthur Aikin, Esq. Sec. Geo. Soc. respecting a green waxy substance found in the alluvial soil near Stockport, was read.

The purport of this notice was to mention the discovery of a similar substance at the foot of the hill of Menil Montant near Paris, by M. Patrin. It there occurs in alluvial sand accompanied by fresh-water shells.

A communication addressed to the Secretary by the Hon. Henry Grey Bennet, M.P. respecting a whin dyke in Northumberland, was read.

The dyke here described is best seen at Beadnel-Bay, where it forms a kind of pier about 27 feet wide and 300 yards long. It rises in a perpendicular position through several beds of stratified rocks, without occasioning any change in their dip or direction. But the qualities of the different strata where they are in contact with the dyke, differ very notably from those exhibited by the same strata at a little distance from the dyke. The limestone in particular of both the beds that are cut through, is harder, more granular and sparry in the vicinity of the dyke, and is, further, incapable of being burnt into good lime.

The reading of Mr. Phillips's paper on the native oxide of tin of Cornwall, was continued.

Before entering into the crystallographical history of this substance, Mr. P. makes some remarks on the kind of crystals best adapted for goniometrical researches, and states his reasons for preferring the more minute crystals to the larger ones, and the reflecting goniometer of Dr. Wollaston to that in common use. He then proceeds to state the means by which he succeeded in obtaining fractures exhibiting the structure of the crystal; from which it appears that its primitive form is that of an octahedron composed of two pyramids united by their bases which are square, and that this is further divisible through both its diagonals into irregular tetrahedrons.

March 20.—William Blake, Esq. F.R.S. and the Right Hon. Lord Compton were elected ordinary members of the

the Society; and several presents of books and minerals were announced.

The reading of Mr. Phillips's paper on the native oxide of tin of Cornwall, was concluded.

After describing the primitive figure of this substance, Mr. P. proceeds to an enumeration and description of those modifications with their varieties which have been observed by him, and specimens of which are at present in his cabinet.

After describing twelve modifications, the paper concludes with details of those compound crystals usually called macles; of the still more compound ones which are formed by the junction of two macles, and of the most complicated of all, which are macles of macles.

A description of Castle Hill near Newhaven in Sussex, by Hen. Warburton, Esq. Ord. Mem. Geo. Soc. was read.

Castle Hill is a small circular elevation composed of nearly horizontal beds, lying above the chalk in the following order, beginning from the most recent:

1. Sand and rounded flint pebbles.
2. A congeries of oyster shells.
3. A bed of broken bivalve shells, chiefly of the genus Venus.
4. A bed of blue clay inclosing a seam of martial pyrites three or four inches thick, composed entirely of casts of bivalve and turbinated shells.
5. A bed of indurated marl, the lower part of which is obscurely slaty, and contains between its laminæ, leaves apparently of some tree of the willow tribe converted into coal.
6. A seam of coal three or four inches thick.
7. Marl of a sulphur yellow colour, including large crystals of gypsum.
8. Sand.
9. Chalk.

A notice respecting an accidental sublimation of silex, by Dr. M'Culloch, Ord. Mem. Geo. Soc. was read.

A mixture of the oxides of tin and lead was put into an earthen crucible, and covered by another inverted over it: the mass was exposed to a high heat, and on opening the crucibles the empty part of each of them was found lined with capillary shining crystals; which by the usual methods of analysis proved to be pure silex.

WERNERIAN NATURAL HISTORY SOCIETY.

At the meeting of this Society on the 18th of Jaunary, Professor Jameson read a paper on porphyry, in which he described several species of transition-porphyry, as occurring along with grey-wacke, &c. in different parts of Scotland. He also gave a particular account of flœtz porphyry, which likewise occurs in Scotland, and appears to belong to the old red sandstone formation. The Professor conjectured that this flœtz porphyry may be the mother-stone of the porphyritic felspar lavas which are found in some countries, and consequently that lavas may occur in rocks of an older date than those of the newest flœtz-trap series.—At the same meeting, Mr. E.W. Leach read a description of two species of shark found in the Scottish seas, illustrative of a proposed subdivision of the genus Squalus of Linnæus.

At the meeting on the 1st of February, a communication from Lieutenant-colonel Imrie was read, containing an account of the district of country in Stirlingshire called the Campsie Hills, illustrated by some curious geological facts observed by the Colonel on the coast of the Mediterranean. The Campsie Hills consist of trap-rocks of great thickness, under which sandstone occurs; and below this lie beds of limestone, with slate-clay, clay-ironstone, and some seams of coal. The trap is in some places distinctly columnar, and in many other places it shows a tendency to this form. He observed, that these circumstances might give occasion to some geologists to class the trap of the Campsie district with volcanic products; of which, however, he saw no symptom. He then pointed out, that nature produces these forms both in the moist and in the dry way, and gave examples of both. In the *moist* way, he said that these forms are seen in greatest perfection in warm climates, and drew his example in this mode from the coast of Africa, near the site of ancient Carthage; where a small lake, with a deep clay bottom, had been drained by the accidental breaking down of a part of its barrier, and where the clay deposit had split into vertical columns eighteen feet high, and from a foot and a half to three feet in diameter. The example in the *dry* way he took from the island of Felacuda, one of the most western of the Lipari islands. In the lavas of that island which have taken the columnar form, he mentioned having seen obsidian and pumice, which had been in flow with the lava, and are seen combined in what he termed one of its congealed streams.

REPORT OF THE PROCEEDINGS OF THE IMPERIAL INSTITUTE OF FRANCE* DURING THE YEAR 1811.

Mathematical Department.

(Drawn up by M. DELAMBRE, Perpetual Secretary.)

Methods for definite integrals, and their application to probabilities, and particularly to the investigation of the mean which must be fixed upon, among the results of observations. By Count LAPLACE.

The theory of Probabilities is one of those to which M. Laplace has directed his attention since his entrance upon his career as an analytical philosopher, and to which at different periods he has made many valuable additions. Besides several important memoirs, which he has published in the volumes of the Academy of Sciences, or of the Institute, he has elucidated the subject also in his lectures at the Normal school, in his *Systéme du Monde*, &c.

Thus by extending his information, and by the clear account which he has given, he has enabled every person to form an idea of the most profound part of the mathematical sciences.

The publication to which we now refer is particularly adapted to geometricians who are sufficiently advanced in that science to understand count Laplace's *Analyse Savante*. It is a sufficient eulogium on that work to mention that the Academy of Sciences announced its title, but left its merits to be determined by those who peruse it; and we are under the necessity of following their example. Of the two branches which distinguish this new work of count Laplace, the first is merely a short historical introduction, from which no abbreviation can be made without rendering it obscure and incomplete: in this part we find some novel observations respecting the existence of different branches of the modern analysis, especially the passages relating to finite and infinite, and also to real and imaginary quantities.

The second division of the work shows that all analytical researches are easier unravelled than extracted.

The author confesses that he has reserved various demonstrations on the subject for a work which it is his intention to publish very soon, on Probabilities. We cannot

* This is the title now assumed by the French National Institute.—*Trans.*

do

do better than conclude by giving this information, which assuredly will excite the curiosity of all geometricians. If amongst the applications which Count Laplace makes of his formulæ, we perceive a point which concerns two celebrated analytical philosophers, it certainly should find a place in the present sketch.

It is that passage in which Count Laplace mentions small squares (*petits carrées*). He says that the method proposed by Messrs. Legendre and Gauss corrects the elements in the most precise manner. The learned who have not met with these works, it is probable may wish to know this method of those eminent geometricians who have already gained so much honour by their labours.

M. Legendre, when he directed his attention to the problem of the comet in March 1805, first furnished astronomers with a certain rule to guide them in their number of approximative equations, much superior to those unknown quantities the value of which it was left them to ascertain.

The inevitable error of the observation on which the equations are established, renders it impossible to explain them all at once, and in taking the result of the system of the observations it does not give more explicit satisfaction; all that can be gained is, that the errors are as trifling as possible—that they are equally distributed—and that none of them exceed the probable errors of the observations. To approach nearest to the real value, M. Legendre proposes a principle by which the sum of the squares of the errors must be a minimum.

This method, which he only mentions without giving the analyses of it, he has made the subject of an Appendix at the end of his Memoir, and in which he gives some further developments. It is his opinion, that of all the principles proposed on this subject, there are none more general, more exact, or more easily to be applied. By this means, he continues, there is established amongst the errors a kind of equilibrium which prevents the extremes from being prevalent.

If by any singular event it were possible to obliterate all the errors, he shows that it could only be done infallibly by his method; and this is an important remark.

If after having determined the unknown quantities we carry the value of them into each of the equations, instead of seeing them reduced to zero; in general we shall find a value which will be for each of the observations, the errors of the elements corrected, and it is impossible to diminish their errors without augmenting the sum of their squares.

M. Legendre next proves that the rule by which a mean may be obtained from the result of different observations, arises from a very simple principle of the smaller squares.

This information is of much importance, as far as it authorizes the astronomers to take the value of several hundred observations to form a final equation from them, which will present the means of thus uniting several groups of particular equations, to form as many final equations as may be judged proper, and applying the method of the small squares without engaging in endless calculations.

This remark might of itself be considered as a sort of demonstration; but afterwards, by a happy reconciliation, M. Legendre refers his formulæ to those by which we find the centre of gravity of several equal masses placed around several given points. He concludes that his principle in some measure makes known the centre, around which are ranged all the results furnished by experience in the neatest manner possible.

To explain the method still further, after having applied it to perfect the elements of his comet, he applies it to the last measurement of the meridian. He had to determine the most probable flattening which resulted from the four arcs measured, and the correction of the 45th degree pretty nearly ascertained by the members of the commission.

These two unknown quantities must be found by keeping as close as possible to the five observed latitudes.

He expresses the errors of five latitudes *en fonction* of the two unknown quantities, and his method conducts him to a flattening (*applatissement*) of $\frac{1}{148}$, and to a 45th degree weaker than had been supposed by twelve toises and a half. This flattening appeared to him to be too strong, and its degree too small; but the errors of the latitudes scarcely exceed the errors which we may fairly suppose to exist: he afterwards supposes the flattening as at $\frac{1}{320}$; but then the errors of latitude found by his method go the length of 3, 4, and frequently nearly 6″; which is scarcely credible.

Such are the principles of M. Legendre: we take the opportunity of mentioning him here, because his memoir having been printed in another shape, they have not named him in the volume of the Institute.

In his Precedents, written upon the arc of the meridian, M. Legendre had not in any way mentioned the method which he has denominated that of small squares, (*moindres carrées*,) which appears to decide that in 1799 he was not in possession of them.

Bosco-

Boscovich long since had it in contemplation to make the sum of the positive errors equal with the negative ones; and all astronomers have had this object in view in the construction of their tables. He also maintained that the sum of errors without the distinction of signs was the least possible; which is likewise the opinion of all astronomers: but to be more certain, he gave, according to his custom, a graphical construction of the problem, to which a calculation may be applied when greater nicety is required. It is to be observed, that he introduces the centre of gravity of all the extreme points of the *abscissæ*, which in his construction represent the degrees measured: because it was also on account of the figure of the earth that he undertook his researches.

Count Laplace, in adopting the principal opinions of Boscovich, treated the same problem in a more analytical and more rigorous manner in the 2d vol. of his *Mécanique Céleste;* and he was led to a flattening of $\frac{1}{150}$, almost as great as that of M. Legendre: his 45th degree differed a little less from the arc adopted, and the errors of their latitudes were nearly the same. Thus two methods, absolutely different, led to results almost identical.

M. Gauss, in his Theory of the Motions of Celestial Bodies, published 1809, endeavours to determine the degree of probability of a system of elements for a planet from a considerable number of observations. He soon meets with an insoluble equation, which forces him to take another course. He inquires upon what function, taken tacitly as the base, the principle vulgarly adopted is supported, and what is the value of the mean result between several observations equally well made, which value is not rigorously exact, but only probably so? By this inverted course his demonstration is very analogous to that of M. Legendre.

Setting out from an elegant theorem of Count Laplace, he arrives at a function which gives expressly the sum of the squares, which ought to be a minimum. Hence he concludes, that the principle of the small squares has the same certainty with the common principle which allows the greatest probability to the arithmetical method. But he remarks that this consequence cannot be correct but on the supposition that all the observations are entitled to the same confidence; and in order to render the principle more general, he multiplies each of the squares by a co-efficient, which expresses the probability of the observation to which he refers; and it is the sum thus modified which ought to be a minimum. He afterwards examines whether the eli-

 mination

mination of the unknown quantities be at all times possible, and by what mode of calculation it may be rendered practicable, in certain cases in which it does not appear to be so. He adds, that this subject may give rise to several neat analytical inquiries, to enter upon which would carry him too far from his principal object: he postpones, therefore, to another occasion the methods of reducing numerical calculation to a more expeditious algarithm. After the example of M. Legendre, he entreats calculators not to seek, in the determination of the known co-efficients, a precision which can only serve to lengthen the operations in a useless manner.

XXXV. *Intelligence and Miscellaneous Articles.*

PROFESSOR LESLIE'S DISCOVERY.

The experiments of Professor Leslie, to produce ice by evaporation in the air pump, have been varied and extended in France by Messrs. Clement and Desormes: they have proposed to apply the evaporation, in vacuo, on a large scale, to the drying of gunpowder; which, being done without fire, will be attended with no danger.

The French chemists are engaged in endeavouring to apply the evaporation in vacuo (before stated) to the drying and preserving fruit and vegetables. It may be easily conceived of what advantage this process may be, particularly in the army and navy, by preserving, unchanged, alimentary substances, and also by diminishing their weight and bulk, when they are to be sent to distant parts of the world.

In consequence of this paragraph, we observe that Mr. Leslie has addressed a letter to the Editor of the Caledonian Mercury, and we can bear testimony to the truth of the Professor's claims to the discovery; for we personally witnessed the demonstration of his theory while in London last year, when he freely explained the various important uses to which the principle might be applied, particularly by the introduction of the apparatus into hospitals in sultry climates, and for its general utility in domestic purposes. We understand that he has, since his return to Edinburgh, improved his coolers, so as to produce ice in large quantities, by much inferior powers to those he first used.

Dr. Kelly is now printing a New Edition (the fourth) of his Spherics and Nautical Astronomy with considerable additions, especially in what relates to the Lunar Observations, and Practical Astronomy in general.

To

To Mr. Tilloch.

Sir,—The following is an extract from the Custom House books for the years stated, upon the authenticity of which you may depend. Can any of your philosophical or medical correspondents account for the annual consumption of such an immense quantity of narcotic poison?

Years.	Opium lbs.	Coculus Indicus, lbs.	Nux vomica in form of extract, lbs.
1796	20,691	12,792	2,207
1797	7,183	13,592	2,391
1798	9,891	7,892	2,830
1799	24,914	7,830	19
1800	48,682	31,567	35,602
1801	54,255	30,334	60,132
1802	24,316	115,237	194,377
1803	26,549	81,265	88,873
1804	20,776	56,696	13,611
1805	16,111	72,143	1,092

Meteorological Observations made at Clapton in Hackney, from Feb. 21, to March 20, 1812.

Feb. 21.—A breeze from S.W. blew along masses of *cumulus*, while *cirrocumulus*, *cirrus*, and *cirrostratus*, presented various appearances in a higher and calmer air. The inosculation of the two stratas occassionally caused slight *nimbi*. The wind became high towards evening, with hard showers at night.

Feb. 22.—Rough gales from the S. all day, with hard showers of rain and hail, with some flashes of lightning and claps of thunder; in the fair intervals the various modifications appeared in different stations.

Feb. 23.—Clouds in two altitudes, the lower ones moving rapidly in the wind; in the evening the *cirrostratus* prevailed, while low flocks of scud flew under; at night it formed a fine veil all over the welkin, exhibited a *halo*, increased in density, obscured the moon entirely, and ended in rain. W. and S.W.

Feb. 24.—Snow which had fallen during the night melted; in consequence of which, and of the late hard rain, Hackney Brook overflowed; there was also considerable flood in the marshes of the Lea. Cloudy morning and clear night. N. and N.W.

Feb. 25.—A cold S. wind with much cloud in different strata; loose flocky *cumuli* below, followed by rain and wind. The marshes of the river Lea flooded.

Feb.

Feb. 26.—Haze in the morning, fair day with various clouds, and very clear at night. W.

Feb. 27.—White frost, features of *cirrostratus* and others, followed by a rainy afternoon, but a fair night.

Feb. 28.—Frosty morning and hazy; fair day, *cumuli, cumulostratus,* and cirrocumulative masses above; a sort of vapour intervened, increasing in density; at night showers and increased temperature.

Feb. 29.—Foggy early, then loose ill-defined *cirri;* above, *cumulus* and *cumulostratus;* much cloud in the afternoon. S.

March 1.—*Cumulus* and *cumulostratus, subcirrocumulative* masses above; in the evening *petroid cumulostrati* rose in mountains all round, and *cirrostrati* increased in density, swelled downwards, inosculating, and threatening nimbification; a long vertical band of yellow light appeared above the sun, occasioned probably by refraction through a thin diffused *cirrostratus.* Wind rose at night.

March 2.—A north wind prevailed all day, with *cumulostratus,* and occasional formation of *nimbi,* which gave light showers of snow and hail: clear night.

March 3.—Hoar-frost and overcast sky, followed by small rain; very dark at night. S.

March 4.—Misty, followed by small rain; fair intervals during the night, with a brisk breeze S.W. and N.W.

March 5.—Clouds in different altitudes; sunshine at times; a breeze from N.W.; during the day nimbification, or at least that state of density near approaching to it, was conspicuous in many places. *Cirrostratus* spread far and wide, in the evening threatening rain.

March 6.—Rainy morning early, when it cleared; masses of *cumulus* floated along in the wind as usual, and in a region much higher appeared the *cirrus,* in some places stretched along in bands, in others ramifying in many directions; here wavy or like granulations, there disposed in tufts; in short, it presented all those various and ever-changing figures which I have often before had occasion to speak of, as denoting a great irregularity in the distribution of the electric fluid, to which this cloud appears to serve as a conductor. The *cirrocumulus* also formed in many places. Dark cloudy night.

March 7.—Fine morning, and a breeze from W. Flocks of loose *cumulus* float in the wind; *cirrostratus* stretched along rather higher: still more lofty the *cirrus* exhibits itself under a variety of changing forms, forming here and there *cirrocumulus* of multiform appearance. During the day the

the sky became quite obscured, and rain came on at night. W.

March 8.—Flimsy *cirrus* above mountainous *cumuli*, then *cumulostratus*, and showers of hail and rain; but clear night. N.N.W.

March 9.—Quite clear in the morning; afterwards *cumuli* increased, and the sky was nearly obscured; a shower came on about three; after which it cleared, when I observed *cumulostrati* with *cirrostratus* above: night fair. N. and N.W.

March 10.—Overcast morning; fair day, with heavy *cumuli*, &c. N.N.W.

March 11.—Sunshine early: overcast day, but dry and pleasant; the kind of cloud seemed to be large folded *cumuli*, approaching to *cumulostratus*. N. and N.W.

March 12.—Loose *cirrus* and *cirrocumulus* above *cumuli*, and much haze; afterwards quite overcast.

March 13.—Clear morning; afterwards diurnal *cumuli* arose, and flimsy light clouds were deposited aloft, followed by *cumulostratus* and hail showers, with a brisk north wind.

March 14.—*Cirrus* and others; showers in the afternoon. N.W.

March 15.—Clear morning; afterwards abundance of *cumulostratus*, with some showers of snow and hail. Very clear at night. N.

March 16.—Cold cloudy day, and N.E. wind.

March 17.—Cold raw day: sky chiefly clouded; some snow kept falling frequently. N.E.

March 18.—Fair morning; some *cumuli* and *cirrostrati* appeared; afterwards it became a dark cloudy night. W.

March 19.—Much *cumulostratus*, &c. By night I observed a *corona* about the moon. S. and S.E.

March 20.—Snow, sleet and rain in the morning; small rain continued falling the greatest part of the day.

In addition to the observations on Mons. De Luc's Aërial Electroscope, which I communicated in your Magazine for June and July last, I have to add, that subsequent observations on this instrument have convinced me, that a certain degree of moisture is necessary to its action; but that peculiarities in the state of the atmosphere vary its kind of action; as, for instance, the regularity or irregularity, strength or weakness, of the pulsation of the bells, &c. Sometimes it will not act at all. Neither will the addition of moisture ever cause its irregular pulsation to become regular.

Clapton, March 20, 1812. THOMAS FORSTER.

METEORO-

METEOROLOGICAL TABLE,

BY MR. CARY, OF THE STRAND,

For March 1812.

Days of Month.	Thermometer. 8 o'Clock, Morning.	Noon.	11 o'Clock, Night.	Height of the Barom. Inches.	Degrees of Dryness by Leslie's Hygrometer.	Weather.
Feb. 27	32	43°	36°	29·68	16	Cloudy
28	32	47	38	·60	27	Fair
29	32	44	43	·40	26	Fair
Mar. 1	40	45	38	·40	27	Fair
2	32	46	33	·90	28	Fair
3	29	40	36	·70	0	Rain
4	38	52	37	·87	25	Fair
5	36	47	40	·90	27	Fair
6	40	50	46	·65	10	Cloudy
7	47	54	40	·60	32	Cloudy
8	39	47	35	·84	16	Showery
9	33	46	34	30·20	35	Fair
10	36	44	33	·21	26	Cloudy
11	32	40	36	·20	24	Cloudy
12	36	41	40	·02	16	Cloudy
13	37	40	36	29·89	0	Stormy
14	36	40	32	·92	0	Rain
15	32	40	34	·72	26	Fair
16	32	36	33	·65	20	Cloudy
17	32	34	32	·50	19	Cloudy
18	29	33	32	·45	17	Cloudy
19	30	36	29	·30	17	Cloudy
20	33	43	44	28·91	0	Rain
21	44	53	47	29·12	26	Fair
22	46	50	44	·50	27	Fair
23	40	46	40	·40	0	Rain
24	39	40	33	·26	0	Rain
25	32	40	32	·70	30	Fair
26	30	44	33	30·28	38	Fair

N. B. The Barometer's height is taken at one o'clock.

ERRATA in our last Number.

For *Pyramido,* page 145, line 24, and page 147, line 20, read *Pirimido.*

XXXVI. *Description of an Improvement on* La Borda's *Reflecting Circle. By Mr.* J. Allan *.

Sir, I beg leave to inform you, that on Thursday last, I left at the Society's house, a mathematical instrument, adapted for the use of mariners, which I wish to submit to the Society's attention. It is a Reflecting Circle, commonly called La Borda's Circle, for the purpose of taking altitudes and distances at sea; and which I have greatly improved lately, by fixing the shade glasses different to what had heretofore been done, with some other improvements as a Reflecting Circle. The late Dr. Mackay, in a publication of his called Mackay's Longitude, has a plate of La Borda's original instrument, but the shade glasses are so fixed, as to render the instrument useless, and which he was convinced of on my pointing out to him the fault; he said he would alter his plate to my method, and that he would state it as my improvement; but his death soon afterwards prevented it. I am aware the Society do not confer their rewards without advantageous qualities to merit their sanction. I respectfully say, that I consider my instrument to have merit, both in œconomy, and in the great improvement made on the plan of the Reflecting Circle first invented. I shall be happy to point out this to the Society, and have the honour to be,

Sir,

Your humble servant,

Blewitt's Buildings, Fetter Lane, Dec. 24, 1810. James Allan.

To C. Taylor, M.D. Sec.

Sir,—Agreeably to the intimations of the Committee on Thursday evening last, I beg leave to explain to the Society, the properties of my improved Reflecting Circle; and which, with a Theodolite attached to it, would be useful both to the mariner and surveyor.

The Committee inquired what sort of centre or axis the instrument had. I beg leave to state, it is an improved one of mine. The former way of centering this instrument was only by a single pin, which both indexes acted upon; but the pin had so little bearing in the index, that it was not sufficient to keep the index-glass upright to the plane

* From *Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce*, for 1811.——The silver medal of the Society and twenty guineas were voted to Mr. Allan, for this improvement. One of these instruments is preserved in the Society's Repository.

of the instrument in all its positions; I have therefore contrived to put what is called in our business, a male and female centre or axis, upon a simple but accurate method.

Permit me to make a few observations on circular instruments in general. I believe it will be universally allowed, that it is easier to make a circle nearer to truth, with respect to its horizontal plane, than it is to make a separate part of a circle so.

A sextant is only the sixth part of a circle, and is got flat by means of a plane, as near as the maker can get it, but is not turned on its own axis as a circle is; therefore I have no doubt, but that the best sextant usually made, is very short of the horizontal truth of a sixth part of a circle; and if we were to suppose a circle made of six of the usual sextants, it would be a very untrue circle with respect to its horizontal plane.

It has, therefore, been a general desideratum, that a circular instrument of reflection should be introduced, of simple construction, easy to adjust, and convenient for use. I have been induced to make several circular instruments of reflection in various ways, but none upon so simple a construction, or so cheap, as the present, nor so well calculated to prove any untruth, as my improvement upon Borda's; and I believe it will now be generally adopted for use.

There have been great numbers of Borda's circles made; I myself assisted about twenty-five years ago to make many, also since I have been in business for the last twelve years on my own account, but I never found any of them to give satisfaction till I invented the present improvement.

Captain M'Lennan, who traded to South America, had one of Borda's Circles made, similar to that described in Dr. Mackay's Longitude, but could not use it till altered by me last April.

The glasses in my instrument are moveable to any quarter that a person may wish to use it in; and by taking the same angle with each quarter, it affords an opportunity of proving the correctness of the instrument, which circumstance I hope justifies me in saying, that it is the only instrument of reflection that I know, so well calculated to prove itself. I beg pardon for being so tedious; I assure you that I can make the instrument better than I can write or talk about it.

I have the honour to be, sir,
Your humble servant,

Blewitts Buildings, Jan. 16, 1811. JAMES ALLAN.

To C. Taylor, M.D. Sec.

De-

Description of the Drawing of Mr. James Allan's *Improvement on the Reflecting Circle of Borda.* Pl. V.

The Reflecting Circle, first invented by Tobias Mayer of Gottingen, and afterwards improved by the Chevalier La Borda, of Paris, is an instrument, which in its principle admits of such a degree of accuracy, as to be of the most important service to navigators; but it has hitherto been constructed in such a manner, that the inconveniences attending the use of it have prevented its general adoption among seamen; any contrivances, therefore, tending to diminish these inconveniences, were deserving of the Society's notice. The construction of Borda's circle as they have hitherto been made, is minutely detailed in Dr. Rees's New Cyclopædia, article, *Circle;* and the mode of using it is there explained; it will be therefore unnecessary to describe any thing more of the circle delineated in Pl. V, than is essential to the elucidation of the improvements made by Mr. Allan.

The first of these is in the mode of applying the dark glasses, which are fixed on joints, so as to turn back out of the way, in the same manner as in the sextant; in the old instrument these glasses were fitted into sockets provided with tenants on the indexes, and fastened by a milled head screw, which took much time to change them; the second is the addition of double verniers to the index, carrying the telescope and horizon glass; these read upon opposite sides of the circle, and if a difference is observed between these readings by taking the mean of them, the error arising from any ex-centricity the index may have, will be corrected; and the third consists in fixing the index glass upon an axis, accurately fitted into the centre of the circle; by this means it is assured that the index glass in turning round, shall always be exactly perpendicular to the plane of the circle; in the old method, when the index-bar was merely fitted on a pin fixed in the centre of the circle, it was impossible to make the circle so perfectly flat, or keep the index so accurately in contact with it, as by having an axis. To explain these improvements more perfectly, the reader is referred to plate V, which contains a perspective view of the instrument; A, is the circle with six arms; B, is the index carrying the telescope C, and the horizon-glass D, with the two clusters of dark glasses E and F; at the opposite ends of this index are the two verniers *a* and *b*, the former has the clamp screw and slow movement attached to it, consisting of a screw *c*, which fixed the index to the circle; and *d* is the tangent

screw, which will move the index a small quantity when turned, to adjust it accurately; G is the index mirror screwed upon the index H, which has also a vernier, and a clamp and tangent screw *e e*, similar to the other; I is the handle by which the instrument is held when in use; it is fitted to a socket K, which is screwed to the centre of the circle, and is unscrewed from the circle when packed away; the handle is fitted to a springing socket, so as to turn round upon the socket K, that it may be turned to any side of the circle for the convenience of holding it; it may be fastened by a small milled nut, seen in the figure which binds the ends of the spring socket together; L is a magnifying glass for the purpose of reading the divisions of the verniers; it is fitted upon a pin screwed into the indexes, and may be applied to either. The figure 2 in the corner of the plate is a section, showing the construction of the central part of the circle, where M is a section of the thickness of the circle with a hole through the centre, and a recess turned out in the lower side to receive a centre-piece N, which is fixed in with three small screws; a hole is turned in the centre of this piece, and an axis O is fitted into it with the utmost accuracy, this axis has a flanch on the upper end by which it is screwed to the index H, and upon this, the under glass G, fig. 1, is fastened, by other screws passing through a piece projecting from the back of it; the axis is held in its place by a collet *r*, fitted on a square part of it, and held fast by a screw *s*; beneath this a piece is fixed on in the centre of the circle, the edge of its flanch being shown by *t* in fig. 1, it is part of the screw which holds on the spring-socket K, for the handle I, the upper end of the centre piece N which comes up above the circle, is turned extremely true, and upon this the index B is fitted, or rather a brass ring *v* screwed to it, so as to turn round upon it as a centre.

The telescope C, is fixed to the index by two cocks and by two screws *x x*, in these it can be raised up or lowered, to adjust the different brightness of the two objects seen in the horizon-glass D, the one reflected from the central mirror G, and the other seen directly through it; the dark glasses at E, are intended to moderate the light of the sun, in passing from the index to the horizon-glasses; the frames containing these glasses have holes E through them, to see through the telescope and horizon-glass, the other dark glasses F, are situated behind the horizon-glass D, and may be turned up or down as occasion requires.

The instrument is used in the same manner as the common

mon Reflecting Circle; the angle being first taken on one side of the parallelism of the glasses, and then on the other; so that the angle is doubled, then it is repeated on a fresh part of the circle, as many times as the observer thinks proper, and the product divided by the number of observations taken; the mode of taking these observations is explained at full in Dr. Rees's Cyclopædia, and in Dr. Mackay's publication on the means of finding the longitude.

XXXVII. *Further Extracts from the first Volume of the Report to the Board of Agriculture on Derbyshire. By Mr.* JOHN FAREY *Sen., giving an Account of the principal narrow Rocky* VALLEYS, *of the Strata intersected and exposed by their Excavations, and in the most noted* CLIFFS, CAVERNS, *&c. therein: of the Cliffs in the wider Valleys, and of the modern* SLIPS *or Sliding of Tracts of argillaceous Strata in their Sides, &c.*

THE Rocky parts of Derbyshire and its environs furnish numerous instances of narrow *Valleys*, or Dales (Combes), with precipitous and rocky sides, often exhibiting very fine Rock Scenery, which, as objects of curiosity and interest to the Traveller, seem to require some notice in this place: and being able to mention the most striking particulars, relating to the stratification of each of such Valleys, the following list will, I hope, interest the Miner and the Geologist, as pointing out the best situations for examining and comparing the edges of corresponding strata, on the two sides of a valley, the ledges of Rock in its bottom, and of studying the truly surprising and powerful causes which have operated, in the excavation of such Valleys; a subject which will be further elucidated, by the account of the beds of the different *Rivers* *, in Section VI. of this Chapter.

An Alphabetical List of the Names of the principal narrow and Rocky VALLEYS, *or Defiles, with precipitous Cliffs, in and near to Derbyshire, describing their Situations, the* STRATA *exhibited in their Sides and Bottoms, and the Names of the most noted* ROCKS, CAVERNS, *&c. in each.*

Barbrook Dale, NE of Baslow, about ¾ *m.* long, E of Derwent River, in a NE direction; Cliffs and loose blocks of 1st Grit Rock, a lead Cupola, slag-mill and Sulphur work in it.

* [This account will be found in my last Number p. 192.—EDITOR.]

 Beres-

Beresford Dale, SSW of Hartington, between Derbyshire and Staffordshire, extending about $\frac{1}{4}$ *m.* S, along the course of Dove River, in 4th Lime; ruins of a Castle.

Bonsal Dale, S of the Town, extending nearly W 2 *m.* from Cromford Town to Griffe and Via-Gellia Dales, with branches on the north up to the Town; 1st, 2nd, 3rd, and 4th Lime Rocks, and 1st, 2nd, and 3rd Toadstones, Tufa at Marygrot Spring, Hot Springs formerly: very deep and striking, with a good Turnpike Road through it, towards Buxton: it has two lead Cupolas and slag-mills, a Sulphur work, Calamine works, a Stone Saw-mill, &c. in it*.

Bradford Dale, S and SW of Yolgrave, extending about SW $1\frac{3}{4}$ *m.* from Lathkil Dale; Shale, 1st Lime, and 1st Toadstone (in the River SW of Yolgrave), Slither, or indestructible and barren Lime-rubble on its sides; a prodigious large Spring at Middleton.

Bradwell Dale, S of the Village, extending thence S about $\frac{1}{2}$ *m.* in 1st Lime, with black Chert nodules in very regular layers.

Brook-bottom Dale, NNW of Tideswell, extending about $1\frac{1}{4}$ *m.* from the Town, 2nd Lime, and 2nd Toadstone (in the Brook at its NW end); Black Marble of the 2nd Lime Rock is dug here, an ebbing Well formerly; Road through it, towards Chapel-en le-Frith.

Burbadge Dale, NNE of Nether Padley, extending NNE about $\frac{1}{4}$ *m.* in 1st Grit, with Mill-stone Quarries.

Callenge Dale, SE of Monyash, a branch from Lathkil Dale S, 1st Lime, Slither.

Cave Dale, SW of Castleton, extending 1 *m.* from the Town, 3rd Lime, 3rd Toadstone, and 4th Lime at its E end; a very narrow entrance from the Town, columnar Toadstone.

Combs Dale, S of Stoney Middleton, extending from near Calver WSW about $1\frac{1}{?}$ *m.*, deep, in 1st Lime, and Toadstone at High-field Sough-mouth.

Cressbrook Dale, SE of Litton, extending about $1\frac{1}{2}$ *m.* N from the Wye at Monsal Dale; 1st Lime, and 1st Toadstone at N end; 2nd Lime, and 2nd Toadstone, and 3rd Lime at S end; Slither, Hobsthrust Rocks.

Cresswell Crags, E of Elmton, between Derbyshire and Nottinghamshire, extending E about $\frac{1}{3}$ *m.* in a lifted part of the yellow Lime †, small Caverns.

* [Mention of the effects of a great Fault on the Strata in this dale, will be found in page 33 of the present volume.—Editor.]

† [This is now supposed, an *upper* Rock; see my present vol. p. 105.—Ed.]

Cummins

Cummins Dale, E of Buxton, extending from Dale-end Mill on the Wye about $\frac{3}{4}$ *m.* NW, 4th Lime, with a crystallized granular bed of Limestone on S side; a dry dale, owing to the Swallow-holes at Water-swallows above.

Deep Dale, N of Briarley-foot Toll-Bar, near Chelmerton, extending about $\frac{1}{2}$ *m.* SSW from Marl Dale, 4th Lime.

Devil's Bowling-alley, N of Alderwasley, extending from the Derwent $\frac{1}{3}$ *m.* SW, 1st Grit, with large loose blocks.

Dimins Dale, NW of Sheldon, extending from near the Wye River SW about $1\frac{1}{4}$ *m.*, 1st Lime at SW end, 1st Toadstone, and 2nd Lime.

Dove Dale, NNW of Thorpe, between Derbyshire and Staffordshire, extending northward near 5 *m.* along the course of the Dove, surprisingly deep in the 4th Lime, much Slither, but no loose blocks: the high and isolated Rocks in this grand dale are called Dove-dale Church, Lover's-Leap, Pickerings, Sugar-Loaves, Tissington-Spires, Thorpe-cloud (at the S end), &c. Reynard's Hall, and Cave, and Dove-hole, are curious Caves; there is here also, a fine natural Arch at Reynard's Hall: many very wide and barren or dead Veins cross this dale obliquely.

Dovehole Dale, NE of Fairfield, extending about $1\frac{1}{4}$ *m.* NNW from Great-Rocks dale, in 4th Lime, a dry dale, owing to Swallow-holes at Dove-hole Cotton-mill.

Evam Dale. See *Middleton Dale*.

Flag Dale, SW of Wormhill, extending about 1 *m.* NW from the Wye River at Chee Tor, in 4th Lime, with 3rd Toadstone along its NE border; large Springs at its SE end.

Grange-mill Dale. See *Griffe Dale*.

Grass Dale, NE of Wormhill, extending about 1 *m.* NNW from Monks Dale to Hay Dale, 3rd Lime at S end, 3rd Toadstone, and 4th Lime at N end: a dry dale, owing to Swallow holes in this and Hay Dale above.

Great Rocks Dale, W of Wormhill, extending $2\frac{1}{2}$ *m.* from the Wye NNW to Dovehole Dale, in 4th Lime, with sunk pieces of 3rd Toadstone in it? near the Buxton Road; a dry dale, owing to the Swallow-holes at Dovehole Cotton-mill above.

Griffe Dale (or Grange-mill Dale), S of Grange Mill, extending thence southward about $1\frac{3}{4}$ *m.* to Via-Gellia and Bonsal Dales, in 4th Lime, 3rd Toadstone at its N end; a new Turnpike Road through it.

Hamps Dale, in Staffordshire, NNE of Caldon, extending

about $2\frac{1}{4}$ *m.* SSW from Ilam and Wetton Dales at Beaston Tor, in 4th Lime. The channel of the Hamps River is here dry, when not swoln by great rains, and its waters, which fall into Swallow-holes at Waterfall and Waterhouses, pass more than 3 *m.* under ground to Hamps Spring! W of Ilam Hall.

Hay Dale, S of Peak Forest Town, extending about 1 *m.* N from Grass Dale, in 4th Lime; a dry dale, below the Swallow-holes near its N end.

Hay Dale, S of Wardlow, extending N about 1 *m.* from Monsal Dale, in 2nd Lime, with 1st Toadstone at its N end, and nearly along its eastern border; vast beds of Slither, or indestructible and barren Lime-rubble, on its E side.

Hipple Dale, W of Brassington, extending about $\frac{1}{2}$ *m.* NNE, with a branch E, in 4th Lime; a prodigious Spring breaks out at its S end, near the great Limestone Fault, about once in 20 years.

Ilam Dale, in Staffordshire, NW of the Town, extending thence near 3 *m.* to the Hamps and Wetton Dales, 4th Lime. The channel of the Manifold River is here dry in dry seasons, owing to the vast Swallow-holes at Darfa Cliff, Waterfall and Waterhouses above, until the great Hamps and Manifold Springs break out, in and near to Ilam Gardens; Beaston Tor Rock at its NW end.

Lathkil Dale, N and E of Yolgrave, extending from near Stanton to near Monyash about $5\frac{1}{2}$ *m.*; Shale near Alport, 1st Lime, 1st Toadstone and 2nd Lime S of Over Haddon, Tufa at Alport, Slither, Raventor Rock near Alport.

Markland Grips, NE of Elmton, extending NE about $\frac{3}{4}$ *m.* to Cresswell upper Mill, in yellow Lime.

Marl Dale, NW of Chelmerton, extending SSW about $1\frac{1}{4}$ *m.* from the Wye River to Deep Dale, 4th Lime; a large Cavern.

Matlock-Bath Dale, SW of Matlock, extending nearly N along the course of the Derwent River more than 2 *m.* from Cromford Cotton-mills; Shale S of High Tor, 1st Lime, 1st Toadstone, 2nd Lime, and 2nd Toadstone at foot of the High Tor; Tufa, Petrifying Springs, Hot Springs, and Baths; High Tor, Scarthen Cliff, and Wild-cat Tor Rocks, &c. Cumberland Cavern: a good Turnpike Road through this beautiful dale, towards Bakewell. (See the Section in *Plate* V.*)

* [See plate II. in my 31st volume; and further particulars of its Strata in the present volume, page 195.—EDITOR.]

Meadow

Meadow Dale, S of Tideswell, extending W about $\frac{1}{2}$ *m.* from Tideswell Dale; 3rd Lime, and 3rd Toadstone at its E end.

Middleton (or Eyam) Dale, W of Stoney Middleton Town, extending thence about $1\frac{3}{4}$ *m.* W, 1st Lime, deep and romantic, with several deep collateral branches; Castle, High Tor, Steeple, and Lover's Leap Rocks; Bamford, Charleswark, and Merlin's Caverns: a Lead Cupola and slag mill, and Sulphur work; a good Turnpike Road passes through this curious dale between Tideswell and Sheffield.

Mill Dale, E of Buxton, extending about $\frac{3}{4}$ *m.* NW from Sherbrook and Wye Dales, 3rd Lime at its NW end, 3rd Toadstone and 4th Lime, white Marble, (Tufa); a good private Coach-road through this dale.

Mill Dale, in Staffordshire, S of Alstonfield, extending W a out 1 *m.* from Dove Dale; deep and rugged, in 4th Lime.

Millers Dale, SE of Wormhill, extending W about $1\frac{1}{2}$ *m.* along the course of the Wye River, from Monsal Dale to Wye Dale and Sandy Dale; 3rd Lime, with 2nd Toadstone and 2nd Lime skirting its S border and parts of its N border; the 3rd Toadstone appears in the River, about its middle and at its W end, Tufa. Ravens Tor, and other bold and high Rocks skirt this dale.

Monks Dale, E of Wormhill, extending NNW about $1\frac{1}{4}$ *m.* from the Wye at Millers Dale to Grass Dale: in 3rd Lime, the 3rd Toadstone seen at its N end, where the Buxton and Tideswell Road crosses it, and the 2nd Toadstone skirts both sides of it at the S end: Tufa is found in it at the S end; a dry dale, owing to Swallow-holes in Hay and Grass Dales above.

Monsal Dale, NW of Ashford, extending about NNW by a crooked course (along with the Wye River) of about $2\frac{3}{4}$ *m.* from the W face of Fin Copt Hill to Millers Dale; in 2nd Lime, 2nd Toadstone, and 3rd Lime at its northern end, having the 1st Toadstone and 1st Lime on its eastern skirt at the southern end, and the 2nd Lime along all its western skirt or border: much Slither, or indestructible and barren Lime-rubble is lodged on the sides of this valley; black Marble of the 2nd Lime is dug here, near Little Longsdon.

New-Mills Dale, S of the Village (in Glossop), between Derbyshire and Cheshire, extending about W $\frac{1}{3}$ *m.* from the junction of New-Mills Brook with the Goyte River, in 3rd Grit and Coal Shale, called Tor Cliff. This is the most

most singular and striking Grit-stone Valley, which I have any where witnessed.

Plesley Forge Dale, E of the Town, between Derbyshire and Nottinghamshire, extending E about $\frac{1}{2}$ *m.* in yellow Lime. Hobsthrust and other bold Rocks are here much admired; a large Cotton-mill occupies the site of the ancient Iron Forge.

Ricklow Dale, E of Monyash, extending nearly N about $\frac{1}{3}$ *m.* in 1st Lime; Entrochi Marble is here dug.

Sandy Dale, SSE of Wormhill, extending SSW about $\frac{3}{4}$ *m.* from Wye Dale to near Blackwell Village, in 3rd Lime, and 3rd Toadstone at its southern end: the 2nd Toadstone skirts its eastern border at the northern end, and produces numerous quartz Crystals, or Derbyshire Diamonds.

Sherbrook Dale, SE of Buxton, extending nearly SW about $1\frac{1}{4}$ *m.* from Wye and Mill Dales, in 4th Lime, and a patch of 3rd Toadstone, at the crossing of the Buxton and Ashburne Road, whence a private Coach-road proceeds through this dale eastward.

Small Dale, SW of Peak Forest Town, extending NE about $\frac{1}{2}$ *m.* from Dovehole Dale, in 4th Lime, which on the sides of this dale assumes a columnar structure.

Thatch Dale, W of Wheston, near Tideswell, extending E about $\frac{1}{3}$ *m.* from Grass Dale, 3rd Lime and 3rd Toadstone; 4th Lime on its N skirt.

Tideswell Dale, S of the Town, extending therefrom 1 *m.* to Millers Dale, in 3rd Lime, and 3rd Toadstone which is thrown up therein by a Fault: the 2nd Toadstone skirts along near its E border; Tufa is found in it, at its S end. It is often a dry dale, owing to the Swallow-holes at the S end of Tideswell Town.

Via-Gellia Dale, N of Hopton, extending about $\frac{3}{4}$ *m.* S from Bonsal and Griffe Dales, in 4th Lime. The Hopton-wood Freestone Quarries are on the E side of this Dale, just below the 3rd Toadstone basset. Mr. Gell's private Road passes through this Valley.

Whaley Furnace Dale, N of Over Langwith, extending about $\frac{3}{4}$ *m.* nearly N, in yellow Lime.

Wensley Dale, S of the Village, extending $\frac{1}{2}$ *m.* ESE, in 1st Lime.

Wetton Dale, in Staffordshire, W of the Town, extending nearly N about $1\frac{1}{2}$ *m.* from Hamps and Ilam Dales; deep in the 4th Lime. Thor's House Tor is a remarkable Rock with a natural Arch and Cave, by this Dale, which is dry in dry seasons, below Darfa Swallow-holes, which suddenly

suddenly absorb this considerable River, after it has crossed the great Limestone Fault*.

Winnets Dale, W of Castleton, extending about ½ *m.* W, in 4th Lime, deep and rugged; the Turnpike Road to Chapel-en-le-Frith goes up this steep and curious valley.

Wirksworth Dale, in NW end of the Town, extending NW about ⅓ *m.* in 3rd Lime.

Woo Dale, E of Buxton, exceeding N about ¾ *m.* from Wye Dale, in 4th Lime.

Wye Dale†, E of Buxton, extends E about 4 *m.* from Mill and Sherbrook Dales to Millers Dale, in 4th Lime, and 3rd Toadstone at its E end, the 3rd Lime there also skirting it on each side. Chee Tor, Peterson Pike, and Lover's Leap, are noted Rocks in this Dale, which has some Slither in it, particularly opposite to Chee Tor in Wormhill, where are two very large Springs of Water. The Duke of Devonshire has, I have been informed, a design of extending the private Road for the accommodation of Travellers, from Lover's Leap at the SE end of Mill Dale, through Wye Dale, Millers Dale, and Monsal Dale to Ashford, by which all the Hills between these places, and indeed all those between Buxton and Matlock nearly, would be avoided, besides laying open the fine Rock scenery on the Banks of the Wye River, which has hitherto been but little seen, owing to the great difficulty of access to it.

I have selected the above, as specimens of the narrow and precipitous Valleys of Derbyshire and its environs: the neighbourhoods of Ballidon, Brassington-pastures, Brushfield, Dowall, Flagg, Hartington, Pike-Hall and others, present similar Dales, some of considerable length, and not less striking than many of the above, and which I have visited, but don't happen to have learnt their particular Names; otherwise they would have been included, on account of the facility which such Lists give, of recording a number of highly curious and interesting phænomena, of which Travellers may in future avail themselves: it is to such Valleys also, that Mineralogists and Geologists must principally resort, to become acquainted with the different Calcareous and Basaltic Rocks of this County, to draw materials for the Natural History of each, and for settling

* [See page 32 of the present volume.—EDITOR.]

† Sometimes the term *Wye Dale* is used, to designate the entire Limestone Valley from Buxton to Bakewell, in which sense, it includes Mill Dale, Millers Dale, Monsal Dale, &c.—See further particulars of the strata in these Dales in the present volume p. 198.

the important and contested questions, respecting the origin, and mode in which Valleys were excavated and formed.

It must not be inferred, that high and precipitous Rocks and Cliffs are peculiar to or confined to the class of Valleys of which I have been speaking, since the sides of the wide Valleys, also, abound with Rocks and Cliffs, some of them highly picturesque and beautiful, but such Rocks seldom continue far, without the intervention of grassy or cultivated slopes, such as the sides of Valleys usually present, in districts where no durable or permanent Rocks exist in their strata: whereas, in the narrow Valleys above, such slopes, or interruptions to the continuity of the Cliffs on each of their sides, are rare, and in some instances do not occur at all, within the distances which I have named. The Grit-stone Rocks of this district, seem particularly disposed to appear and disappear repeatedly on the surface at their edges, or in tracing their Bassets through the country; and except of the 1st or lowest Grit Rock, it is a rare thing to find a continued Grit-stone Cliff of any length: some of them, indeed, are so disposed to moulder and fall, on exposure to the air, rain, frost, &c. that Cliffs of such Rocks are never seen; but where *Slips* or slidings have happened, in comparatively modern times, of which there are numerous and striking examples in Derbyshire, particularly in the Shale and shale Grit districts; and as it seems of the utmost importance in Geological researches, to distinguish between Cliffs or Facades of equal antiquity with the Valleys themselves, probably, or such as have originated with, or been increased by, subsequent and sudden Slips*, or by the gradual and recent undermining of currents of the Brooks and Rivers, I shall here give a

List

* Since the above was written, I have read with some surprise, pages 61 and 62 of the recent Translation of M. Werner's "New Theory," on the subject of Mineral Veins, wherein the phænomenon of Slips, as above, is described, and it is gravely maintained, that such, happening "in rainy seasons," have *opened* the fissures for Mineral Veins (to be afterwards filled, I supposed); as though the conchoidal fracture of a Slip from an adjoining Hill, close pressed and ground by the moving load of softened Earth, had any relation to a rake Vein! This is not however solely relied on for the opening of Veins; but we are informed (p. 48), that while the beds of the Mountains were "at first wet, and possessed little solidity," the mass "yielded to its weight," "sunk and cracked," "falling to the *free* side;" now, notwithstanding the parade of mathematical definitions and preparations, at pages 88 and 89, I would venture to ask any one who knows Derbyshire, and the large rake Veins which cross the comparatively flat districts, that lay between Bradwell and Tideswell or Wardlow, between Sheldon and Monyash, between Winster and Bonsal, &c. which is the *free side* in any of these cases? or what sort of an action of *their own weight* it must have been, which caused such immense lumps of Limestone to start a few feet asunder, in so many

List of such SLIPS, *or modern sliding and sinking of tracts of ground on the sides of Hills,* as I have noted in the course of my Survey, viz.

Alpert, in Hope Woodlands (Castles).
Atlow W, Win House SE, recent.
Bakewell, S of the Town; and E (Edge).
Bramcote E, Staffordshire (Black-Meer of Moredge).
Bretton NE, in Eyam (clough).
Calver S, in Back Dale (North Cliff).
Castleton NW (Mam-Tor Hill S side, large).
Charlesworth, in Glossop, NE (Hargate Hill), and SE (Combs Rocks), in 2nd Coal Shale.
Darley N (Stone Cliff): and S (Oaker Hill).
Darwent Chapel SE (Shuts ding Bank, and Lady-bower): N (Hag-hole): and NNW (Ronksley).
Edale, in Castleton (Mam-Tor Hill NW and NE sides), very large: (Back Tor, of Lose Hill W end); and Lee Farm.
Great Hucklow N (Bur-Tor).
Haddon Park W, in Bakewell.
Hathersage E, N of the Cupola.
Lea, near Matlock, SW (Woodseats): and (White Tor).
Ludworth, in Glossop, NE (Stirrup Benches), in 2nd Coal Shale.
North Anston, Yorkshire, N (Clarkes Stones) in yellow Lime, &c.
*
Rowlee, in Hope Woodlands, N, very large.
Stannington, near Sheffield, Yorkshire (Little-Matlock Cliffs), in 1st Coal Shale.
Stanton Leys, near Darley, N (South Moor).
Starkholmes, in Matlock.
Tor-side, in Glossop, near Woodhead.

many instances, quite down to the Toadstone (and again under it, as some would remind them)? It is just hinted to us, it is true (p. 50), that "the shrinking of the mass of a Mountain, *produced by desiccation*, and *still more by Earthquakes*, and other similar causes, may also have contributed to the formation of rents," for Veins. As a comment upon all this, the learned Translator tells us, truly, I believe, (p. 256) that "the *widest Veins* generally occur in the most horizontal strata." Since the above, Dr. James Millar, in his Appendix to Williams's Mineral Kingdom, professing to give a view of the "Theory of Werner," omits all notice of the opening of Mineral Veins by Slips, Pressure, Earthquakes, &c. as above, and merely says, that they happened, according to this Theory, "by the *drying* and shrinking of the newly formed strata"—Perhaps the Doctor chose this course, out of tenderness to the author of the Theory.

* [Mr. F. informs me, that a large and curious slip at Overton ½ *m.* S (Raven's Nest Tor) in Ashover, has been omitted above.--EDITOR.]

Upper

Upper Ashop, in Hope Woodlands, NW (Combs-Tor), very large; (Dine-Sitch Tor): and N (Collet Hay).
Wensley, near Winster, N.
Willersley, in Matlock, NE.
Wirksworth, NW (Bole-Hill).
Woodhead, Cheshire, SE.
Woodseats-Hall, in Barlow, ½ *m.* SW, in 2nd Coal Shale.

All the above Slips, except five, which are mentioned, and numerous other smaller ones, are occasioned by the Limestone Shale; sometimes the sunk pieces contain part of the 1st Grit Rock on the Shale, or large pieces of shale Grit, or shale Limestone, perhaps, in their masses.

As in the judgement of some I shall be thought, probably, to have said too much already on the form and surface of the County, I shall now close this Section by mentioning, that Derbyshire contains about 972 square English miles, or 622,080 statute acres*.

XXXVIII. *Description of an inclosed Grindstone, intended to prevent prejudicial Effects to the Persons employed in pointing Needles. By Mr.* Thomas Wood †.

Sir, I herewith submit to the inspection of the Society instituted for the Encouragement of Arts, &c. a model of an inclosed grindstone, intended to prevent prejudicial effects to the persons employed in pointing needles.

This grindstone is inclosed in a case of wood or metal, and hath a hood wherein a square of glass is inserted, designed to admit light on the articles under operation.

The particular advantages attending a grindstone suspended in this manner, with a hood and a damp cloth, are, that the stream or current of air, formed by the motion of the stone on its axis, is confined by the case under the hood of which

* Which is the result of a careful scaleing of my large Map. In the Original Report, Mr. Thomas Brown stated the quantity at 720,640 acres; the Parliamentary Returns of the Poor's Rates, as stated by Mr. Thomas Poole, make Derbyshire contain 689,280 acres, which last, considering that many of the Parish quantities must have been stated by estimation, agrees sufficiently near with mine above. About the year 1756, when Benjamin Martin published his Natural History of England, this County was stated to contain only 540,800 acres; but a Dictionary of Arts and Sciences, now publishing in London, magnifies its dimensions to 1,600,000 acres! See other particulars of the acres in this County, in Sections IV. and VI. of this Chapter.

† From *Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce*, for 1811.—The silver medal of the Society was voted to Mr. Wood for this invention, and a model of the Apparatus is preserved in the Society's Repository.

which it enters, and carries with it the fine particles of steel and sand, which it deposits on the lower part of the inside of the wet cloth, which forms the connection between the sides of the case, by these means rendering the operation of pointing needles less pernicious to the health of the operator. The stone may be worked by hand, by water, or machinery.

I am, sir, most respectfully,

Great Berkhampstead, Herts, January 25, 1811. THOMAS WOOD.

To C. Taylor, M.D. Sec.

Description of the Engraving of Mr. THOMAS WOOD'S *Improvement in the Grindstones for Pointing Needles.* Plate VI. fig. 1.

The grindstone A is inclosed in a box or case, formed of two circles of wood, one marked B, and another on the opposite side, which cannot be seen in this view; *a a* are two thin iron plates placed so near to the stone, as to be as close to it as possible without touching it; two other plates *b*, support a pane of glass at *c*, which at the same time that it prevents the dust from being thrown over the stone into the air, admits light to that part of the stone where the needles are applied; the remaining space between the edges of the two circular boards B, is filled up by a coarse cloth D, which encompasses about ¾ of the edge of the stone, and is then hooked up to the iron plates *a*, by means of two bent pieces of plate iron, to which the cloth is sewed, one of which is seen at *d;* and these are hooked upon other bent pieces, which form part of the plate *a a;* the cloth is wetted when put on, and will then catch the dust which is produced by the grinding, and when it has accumulated much, by unhooking the cloth it may be shook out, and the cloth being wetted is hooked on again; as the stone wears down the piece of plate iron *e*, situated in a groove formed by the edges of the plate *a*, is slided forwards to follow up the reduced edge of the stone, and other plates are put into the groove after *e*, when they are required; the case B is supported by a cross-bar of the frame in which the stone revolves, and which may be made in this or in any other form; the stone is turned in the usual manner of grinding-mills for needles, by a strap passing round a rigger, fixed on the end of its spindle; but this cannot be seen in this view, it being hidden behind the stone.

XXXIX. *De-*

XXXIX. *Description of a Contrivance for conveying Steam from Boilers.* By Mr. GEORGE WEBSTER, *of Leeds**.

SIR, IT is with pleasure that I communicate to you the contents of this paper, hoping that this invention will be beneficial to the public; the leading feature of the contrivance is simplicity, and that may possibly be a fair recommendation, at least such it seems to me.

I have just finished a new erection, for my better accommodation in the whitening and stoving of woollen cloths, and having been long annoyed in this business with the steam from the hot water in the pans, I determined if possible to get quit of it; besides I had ample proof in my old building, how injurious the steam was to the timbers of the floors, &c. Permit me to say, that I spent a decent sum of money to no purpose, and was giving up the idea, in despair of its accomplishment, when I hit upon this expedient, which answers my most sanguine desires.

I presume that this easy method of carrying away steam has never yet been in practice, and if once known will be of very considerable utility. In the numerous instances in trades where steam is inconvenient, it offers a ready riddance; to the timber in buildings, and to the furniture in houses, private kitchens, &c. it affords a desired security; but in many trades, as glue-makers, tallow-chandlers, &c. where the effluvia, united with or without water, is offensive and obnoxious, it must be doubly and trebly valuable; and these cases are more numerous than I can recite or am acquainted with. The evaporating matter needs no longer to be the plague of the workmen, or the nuisance of the neighbourhood.

Hoping that the plan, though simple, and that the object, though not of the first magnitude, will be deemed worthy of the approbation of the Society,

I remain, sir,

Your most obedient servant,

GEORGE WEBSTER,

Stover, Leeds.

Leeds, April 16, 1810.

To C. Taylor, M.D. Sec.

SIR,—IN the model I have sent to the Society, the steam chimney is carried up as high as the smoke chimney, which is

* From *Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce,* for 1811.——The silver medal of the Society was voted to Mr. Webster for this communication, and a model of the Apparatus is preserved in the Society's Repository.

is the case at my works, being my first essay; but this is not immediately necessary, for in the bleach house belonging to Messrs. Benyon, Benyon, and Baze, flax-spinners, of this place, I advised the steam to enter the smoke flue, about six feet above the top of the pan, and with the same good effect.

Several of my friends here have adopted them in their kitchens, and wash and brew-houses. The steam flues are variously curved, as the situations required them to reach the nearest or most convenient smoke chimney, and with the same uniformly good success. I would, however, recommend, that at the lower part of the aperture, where the steam enters a smoke flue, a stone may be made to project a little way into the chimney, in order to break the current of the ascending smoke, and thereby facilitate the entrance of the steam.

I would remark further, that in some cases a curved or angular form may possibly be found the most eligible for the steam chimney, in order to prevent a gust of wind, or any other casualty, from forcing soot down into the liquid in the pan.—I have not yet witnessed any immediate necessity for it myself, and therefore merely suggest it as possible, but yet very easily remedied.

I am, sir,

Your obedient servant,

Leeds, May 23, 1811. GEORGE WEBSTER.

To C. Taylor, M.D. Sec.

Reference to the Engraving of a Section of Mr. WEBSTER'S *Apparatus, for conveying Steam from Boilers, represented in Plate* VI, *fig.* 2.

AA, the brickwork surrounding the pan.

B, the steam chimney, made of wood, about two feet broad and six inches deep. A small opening at the back part of the pan admits the steam into this chimney, it may from thence be carried up to the top of the building or turned into any smoke chimney near at hand.

In order to keep the water in the pan as hot as possible during the night, there are two dampers in the steam chimney at D, and if both these dampers are shut, and the whole top of the pan covered closely over at *c*, the boiling water even when the fire is withdrawn, will keep hot for the workmen till the next morning.

CC, are loose boards, fitting close to each other, and covering completely the better half of the circle of the top

 of

of the pan; and upon this circumstance depends the whole secret of getting quit of the steam. If you remove these boards or partial coverings, the steam chimney loses all its use. The letter *b* shows the part of the top of the pan which should be left open to admit to the workmen a ready communication with the hot water, and through this open part a current of cold air is constantly seen to press and force the steam rapidly up the steam chimney.

It is proper to add, that there must always be an empty space of two or three inches between the surface of the hot water and the under part of the cover *c c*, so as to permit the steam to pass to the bottom of the steam chimney. To effect this purpose, and at the same time to allow the copper to be full of hot water, a rim or curb of wood F, about three inches thick, should be fixed upon the top of the copper, and upon this the covering boards *c c* placed; this allows sufficient room for the steam to press forward to the steam chimney at all times.

The cover and wooden steam chimney are removeable, and may serve for another copper if both are not wanted at the same time.

XL. *Geological Observations on the County of Antrim, and others in the North-east Part of Ireland, in an Attempt to arrange the numerous Facts, stated by Dr.* William Richardson *to the Royal Irish Academy, and to the Royal Society*, and those recently published in the Rev.* John Dubourdieu's *Statistical Survey of Antrim, by Dr.* William H. Drummond, *in the Preface and Notes to his Poem "The Giant's Causeway," &c. and to refer each of them to one of four principal Strata; separating such as belong to the Alluvia: with incidental Facts and Observations respecting other Districts, &c. &c. By Mr.* John Farey *Senior, Mineral Surveyor.*

To Mr. Tilloch.

Sir, The announcement which Dr. William Richardson made in your 37th volume, page 368, of the Rev. John Dubourdieu being employed on a *Statistical Survey of the County of Antrim* in Ireland, to which he meant to contribute his assistance, as to the Geological Facts of that most interesting County, has made me anxiously expect the appearance of this volume: and in the perusal of which I

* See vols. xxxv, and xxxiii of this Magazine.

have

have lately been gratified, through the kindness of G. B. Greenough, Esq. the able President of the Geological Society of London, who at the same time lent me some notes made by himself, when in the country S of Lough Neagh, in the last year, with the Rev. Dr. William Hamilton Drummond's poem "The Giant's Causeway" (having a copious Preface and Notes on the Mineralogy of Antrim) and the Rev. Richard Barton's Lectures on Natural Philosophy, giving many particulars of the shores of Lough Neagh. I lament that I have not seen the Rev. G. Vaughan Sampson's Statistical Survey of Londonderry or Derry County*, or the Surveys of Tyrone, Armagh or Down, or read any connected account of their Strata; only the incidental circumstances, noted in the works and paper above mentioned, except the slight account of the *Drumglass* Coal Strata given by Mr. Whitehurst in his "Inquiry concerning the Earth," 2nd Edit. p. 246, and which are quite insufficient to prove *the identity or otherwise, of the Coal-measures near the* SW *corner of Lough Neagh and those at the* NE *corner of Antrim*, and of Ireland? which to me appears a question of considerable importance, and I have hopes, that by stating some facts from the above sources, and conjectures of my own founded thereon, as to this point, I may obtain from Dr. Richardson or others of your Geological Readers, the further facts necessary for confirming or correcting what I am about to offer on this head; as well as on another scarcely less important, viz. *Whether the Coal-measures at the* NE *corner of Antrim under-lie or over-lie the great Basaltic Series*† which occupies the surface of great part of that County? a point which I lament to find Mr. W. rather obscure upon, who after speaking of the Basaltic Sea Cliffs, ranging from the west and finally terminating upon a stratum of white Limestone at Ballycastle, says, Inquiry, p. 259, "and where a new arrangement of strata

* Who, I am told, intends to make a *Section* across Antrim and Derry, and continue it across the other Counties to the Western Coast of the Island.

† Dr. W. H. Drummond dispatches this part of his description of the NE extremity of Antrim, in the manner of too many Wernerians, by saying, p. xiv. "at Murloch the *primitive* strata are seen dipping to the NW in an angle of about 45°. Freestone occurs here between the strata of Trap," and adds, "The Basaltic formation which is here renewed, attains its highest elevation at Fairhead, rising in proud magnificence *over* alternate strata of freestone and Coal, and thence gradually sloping down to the strand of Ballycastle." Dr. R. speaking of this same spot says, at Murlogh "the precipice is composed of alternate strata of *Freestone* and *Coal*, inserted between mighty strata of columnar Basalt." Appendix 81: and says nothing of the *primitive* strata of Dr. D.!

 commences

commences, quite of a contrary nature;" referring to his engraved Section, across the mouth of the Glenshesk or Ballycastle Valley; whence it might be inferred, that the Coal-measures *over-lie* both the great Basalt and the white Limestone, though doubtfully, on account of their dips being shown as very different and the Sea preventing their junction from being seen; but which difference of the dips when viewed in this direction, viz. looking S, seems inconsistent with what Dr. R. says in your Magazine, vol. xxxiii. p. 200; viz. that this Basaltic stratum (of Fair-Head, which he seems throughout to consider as the *great* Basalt of the other Cliffs on white Limestone), lies "with *the same angle* of inclination in which *it was* disposed along our whole (north) Coast, that is, *a slight* ascent to the north," which he elsewhere states to be 7° to 10° of inclination, Appendix, p. 95, to Mr. D.'s Antrim Stat. Surv. agreeing with Mr. D. p. 76, who represents all these Coal-measures, as "tolerably regular in their disposition, forming *a small angle* with the horizon *to the south*," and being of course nearly level in the cross or E and W direction, as Mr. W.'s section shows the Coal series: his position however of the Basalt and subjacent Limestone, don't accord with what Dr. R. says vol. xxxiii. p. 200 (see also vol. xxxv. p. 373), viz. that on the west side of Ballycastle Pier, the bold basaltic precipices suddenly disappear, and at *a lower level* disclose *the substratum*, which appears to be an alternation of Sandstone and Coal, sometimes with bituminous schist," or *Shale*, as I should call it, to distinguish it from the *Schistus* or *Slate* south of this, spoken of by Dr. R. Appendix. 95, as having *a dip of* 60°, but in which observation I cannot doubt that he mistook the *stratula* for the lamina of stratification (if it has any such), against which mistake Mr. Arthur Aikin and other observers were cautioned, by a Correspondent in your 38th volume, p. 357; Dr. W. H. Drummond, in speaking of the Red Sandstone in Cushendall Bay, falls, probably, into this same error, Preface xiii.

After considering what I have read as above, I have adopted the suppositions of the Drumglass and Ballycastle or Tyrone and Antrim Coal-fields, containing detached parts of *the same Strata*, which belong to *the top* of the great Antrim Basalt, and that they once connected thereon between these two Coal fields; and shall reply to Dr. R.'s question, Appen. p. 31, by saying, that here *Coal-measures do intervene between Basalt strata*, according to the statement of Mr. Whitehurst, p. 260, of Dr. Hamilton (as

quoted

quoted by Mr. D. p. 86), and by himself, Appen. p. 81, as before observed; or rather, they *over-lie* the great Basalt, and *under-lie* the *Whinstone*, as both of the authors, first above quoted, call this small or upper Basalt, although Mr. D. rather obscures this interpretation, in page 86, by saying, that the Whinstone is "the same (kind of?) stone as the Basalt of Fair-Head, and is imperfectly columnar:" we are no where however told, what space to the southward this Whinstone occupies, before the Slate commences? and whether other Coal-measures do not come on upon this Whinstone? (as I think very probable); or how or in what form the Whinstone or its covering strata adjoin to (whether by underlieing or overlieing) the Slate S of them?; on all which points Dr. R. is rather surprisingly silent, and does not any where, I believe, mention, or allude to the *Granite** found S of the Coal-field, on Ballypatrick Mountain, mentioned by Mr. D. p. 84, and on the Mountain above Cushenden (perhaps the same?) accompanied by Gneiss (p. 92 and 93), where "the enormous fractured mass of this substance, which hangs over the Road on the left, and the disjointed fragments that lie under it on the right, as the hill is descended, cannot fail of striking the beholder with awe;" at the bottom of page 93, Mr. D. is more particular in describing the places of the Limestone, Granite, Gneiss, and red coarse Sandstone (or Puddingstone), to the Traveller. Dr. R. in describing the edge of the basalt on the Limestone, in this part, App. p. 21 and 43, mentions only the *Slate*, and by directing the devious steps of his Tourist (App. p. 95), up the southern Road from Ballycastle (instead of that SE) shows him this *Schistus* only: and in so doing (like Dr. Townsend, as I suspect) loads the Cosmogonists with unnecessary difficulties, respecting the unconformableness of the Slate and Coal-measures, as already mentioned.

I shall now take the liberty of suggesting (in hopes of early correction through your means, wherever I am wrong) what appears to me to be the structure of the north-eastern part of Ireland, from the facts disclosed in the very interesting accounts which I have been reading, and the knowledge I have of similar or analogous phænomena in very distant situations.

First then, I suppose that the lowest known Stratum or assemblage of strata in this district is a very thick *Red*

* At Cushleak N of Newtownglens, Gneiss, mica Slate, and Granite are found, and occupy the Coast, according to Dr. D. Preface xiii: and "dark-blue primary or transition Limestone," at Tor-point, p. xiv.

Marl, one of the three, probably, which are mentioned in my reply to Dr. R.'s Letter, p. 442, of your 37th volume, and closely allied in its properties, though not the same, which I have somewhat explored and treated on in my Derbyshire Report, vol. i. p. 146, and in your present volume, p. 28.

Dr. R. when describing the great *Basalt* stratum in your 33rd volume, pages 105, 113, and 204, and in Mr. D.'s Appen. p. 62, 80, &c. speaks of "the *little systems,* by the aggregate of which our coast is formed; nature having *changed her materials,* or their disposition, or both, every two or three miles:" "Nature in the formation of her arrangements has never acted upon an extensive scale in our Basaltic area," &c. "Whenever there is *a change of materials,* by the introduction of *a new system,* the lines of demarkation (are) always distinct and well defined; yet, the *different materials pass into each other* without interrupting the solidity and continuity of the whole mass." "We (addressing Mr. Davy) studiously sought for the points where nature had made *any change in her materials,* or their arrangement, hoping that at the junctions of these *little systems* we should find," &c.: and which are the kind of passages, to which I alluded, vol. xxxiii. p. 257, as not perfectly understanding them two years ago, but which I think that I now do, as applied by Dr. R. to the anomalies or occasional changes in the substance, or the structure, or the form, &c. of what he still considers as *the same stratum* of Basalt, notwithstanding such changes. In the mention which Dr. R. has since made of the matters below white Limestone (except speaking of schist in several places), App. pages 21, 22, 47, &c. he says, they compose "a district in which the component fossils are much diversified," having "more diversified materials and more diminutive and irregular arrangements," and again, he speaks of the valley between Cave-hill and Carmoney being excavated through the basaltic and calcareous strata, "and the *more irregular materials* upon which they rested," &c. From all which I conceive, that Dr. R. will find no great difficulty in understanding, and perhaps in admitting the statements in my Derbyshire Report, vol. i. p. 147 to 156, 280, &c. as to the anomalous, accidental, or chance Beds and nodular and huge anomalous Concretions or rudely crystallized Masses in the Red Marl strata, in and near to that County, and elsewhere; whatever he may think of my present attempt, to refer the very various and dissimilar substances in the lower part of his series (to which he

he so often alludes) to one very similar and immense stratum of Red Marl, as mentioned above; within which they are now actually imbedded, either isolated, or touching or enveloping one another, or occupying its entire place in *local* tracts: and I am extremely anxious, to engage so deliberate and careful an observer as Dr. Richardson, in comparing these suggestions with *the facts* within his knowledge or reach, respecting all the north-eastern Counties in Ireland, as soon as may be, through the medium of your Magazine, or any other he may prefer:—but to proceed:

This thick Red Marl stratum does not appear to have formed a single plane, but to form a *Trough* on a large scale, such as I have traced in several parts of England*, the central or lowest line of which is to be sought for, by the dips of the superficial strata towards it † (where such strata are regular), from near the north-western corner of Antrim along the vale of the lower Bann River between Antrim and Derry, across Lough Neagh and thence perhaps along the vale of the upper Bann, and line of the Newry Canal between Down and Armagh Counties, or some miles to the west of this perhaps, and into the Eastern Sea, in Dundalk Bay, probably; and I think it likely for reasons to be stated hereafter, that this trough declines or deepens *towards the south* as far as the south side of Lough

* As between the Isle of Wight and the main Land (extending E to the French Coast and W into Dorsetshire and perhaps into Devonshire); up the course of the Thames from its mouth into Wiltshire; and of which an instance is particularized in the East and North Ridings of Yorkshire, in your present volume, page 97 and 98: they are indeed so common and important a phænomenon in the position of the British Strata, that Mr. *William Smith* used some years ago to think, that thereby he could account for the very crooked and fingered form of the endings of the strata, without admitting such to be the remains of strata of which the other parts are denudated and gone, as I then and since have maintained, and as Dr. R. has since written respecting the irregular outlines of strata which I never saw. Mr. Smith, when explaining himself to me and others on this subject, has often taken a sheet of writing paper, and folded it up as the paper or mounting of a lady's Fan is done, except the folds being parallel instead of converging as in the Fan, and pulling it nearly open, has, holding it inclining slightly towards the South-East, said, "this is nearer to the position of the strata on the south and east of England, than any one plane, and the greater part of that country will be found to consist of nearly parallel Ridges and Troughs."

Local bumps, humps, or elevations in the strata, and basins, swilleys, or local depressions from all sides, I find to be also common, and not less important to be traced and investigated, than the long Troughs and Ridges above mentioned, as I hope to show, by the results of a particular Survey of a large district in Derbyshire, which I have in hand, for the truly liberal President of the Royal Society.

† Of which Mr. D. takes a general notice (quoting the Rev. G. V. Sampson) in p. 27 and 31 of his Stat. Surv. of Antrim.

 Neagh,

Neagh, and perhaps much further. The northern edge or end of this great Marl stratum seems submerged in the ocean from Ballycastle to Lough Foyle, or near it, rising towards (and producing as I expect) the mountains in the north-eastern parts of Donegall; as its western side do those of the western parts of Derry, Tyrone, and those of Monaghan and Louth Counties too, perhaps, in so many "little systems," as the tracts of different Rocks therein may not improperly be styled (in the language of Dr. R.), when compared with the entire mass of the stratum I am describing: whose eastern side seems to produce the mountain, on the eastern side of Down County; but with respect to all which, I am left to much conjecture, owing to the works I have read containing only the mention of *Schistus* or Slate (belonging to this stratum) on the western side of the trough*, by Dr. R. in your 33rd vol. pages 195, 199, 204, &c. and App. 34, &c.: except a few facts relating to the County of Down, which will appear in their more proper places hereafter. With respect to the eastern side and the top part of the edge of this great and lowest known stratum of this district, as far as they appear within the county of Antrim, though the space is vastly smaller, my materials are more ample, and which I shall proceed briefly to mention, requesting a careful comparison of them with my Derbyshire Report, but more so with the phænomena of the Red Marl stratum itself, that are there detailed. The substances then of this district are:

Red Marl or Clay, with its usual characteristic streaks and beds of greenish blue or blue marl-like Earth, which appears (at Cave-hill) at the top of this stratum, Mr. D. p. 69 and 72, (a thin *bitumous schist*, Dr. D. pref. viii.); Red Clay from 40 to 106 feet deep and more, beneath Belfast Town, p. 558; in places along the vale of the Lagan and coasts of Belfast Bay and the Ocean, to the Island Magee, as at Maheramesk N of Hillsborough, Maheragall, Belfast, and Carrickfergus, Mr. D. p. 74, the Forth vale near Belfast, and Castlechichester in Magee Isle, p. 72; in the Forth and Woodburn valleys ("extensive beds of Clay, commonly red, sometimes of a deep blue and spotted,") and on the shores of Carrickfergus, where it makes *Bricks*, Dr. D. pref. vii.; and Marley Clay at Killroot, Mr. D. p. 139, &c.

Gypsum in the Marl or red Clay, white, yellow, reddish,

* Unless the red and greenish Marl observed *by Mr. Sampson* were in Derry, as might be inferred, from his being the surveyor of that County, mentioned by Mr. D. p. 69.

and

and fibrous, in beds not exceeding two feet thick, in the Forth and Woodburn vales and the shores of Carrickfergus, Dr. D. pref. vii. in the Forth vale, and on the Coast of Belfast (Dr. R. vol. xxxv. p. 375) and thence to Castlechichester in Magee Isle Mr. D. p. 72, and at Megabuyhill (in searching for Coals!) in Maheramesk, Mr. D. p. 74; the gypsum having been called Talc by Mr. Barton p. 106.

A putty-like substance found in the Red Clay, often laminated, fine and most unctious to the feel (Mr. D. p. 69), is perhaps a kind of *Fullers' earth.*

Salt-Springs (indicative, no doubt, of Rock Salt beds in the Marl below); the strongest in Ireland is on Noah Dalway's Estate near Carrickfergus, Dr. D. says pref. vii. At Ballyhill, and at Red Hall in Magee Isle, there are pure, but not strong salt springs, Mr. D. p. 142.

Mineral Springs (purging nitrous) in marley Clay at Killroot, and near Carrickfergus, Mr. D. p. 139.

Sandstone, variegated, and containing clay galls, is said to be lowest stratum seen, (dipping W) on the beach at Ringin point by Dr. D. pref. p. vi. "Sandstones of different colours, different degrees of hardness, and differing in the size of the grains which enter into their composition, form the grand basis of this County. They appear at the southern extremity of it near Spencer's Bridge, where it joins the County of Down. From thence they may be traced along the whole valley to Belfast and along the shore to Carrickfergus, a tract of not less than twenty-two miles," Mr. D. p. 91; and at Whitehouse Point, Dr. R. vol. xxxv. p. 375. "The depth, to which the Sandstones go, is very great and quite uncertain; this has been tried in many places near Lisburn, where after boring near 200 feet, the undertaking has been abandoned: and at the Freestone Quarry at Scraba in the County of Down 450 feet have been bored through without success," Mr. D. p. 92. The surface of this stratum makes a sandy soil W of the Lagan, from Maize Course to near Belfast, p. 23. "A fine section of this sandstone may be seen at Macedon Point, arranged in many-coloured stripes, and cut by vertical veins of an unctious argillaceous substance, resembling Fullers' Earth," Dr. D. pref. vii. "On the western shores of Cushendall Bay, we meet with a red Sandstone, in beds five or six feet thick, dipping to the E (*stratula*, probably?) at a high angle:" "a curious breccia or *puddingstone* consisting of rounded pebbles of quartz imbedded in a red sandstone cement: the caverned Rock, on which Red Bay Castle stands,

stands, and the grotesque caves of Cushendun, are found in this material," Dr. D. pref. xiii. and p. 143: this pudding-stone is noticed particularly by Mr. D. at page 92 and 94. I am inclined however to think it a coarse and very *irregular gritstone*, as to the size of the grains, of which I have seen many examples in Red Marl districts.

Magnesian Limestone, this appears on the S shore of Belfast Lough, at Hollywood in Downshire, and by Dr. D. pref. vi. is supposed to underlie the Sandstone: many miles N of this at Tor Point there is "a dark-blue primary or transition *Limestone* with veins of *chlorite* and *calcareous spar*," Dr. D. pref. xiv.

Gneiss, *Mica Slate*, and *Granite* appear in Cushleak, the shores here being bold but not perpendicular, Dr. D. pref. xiii.; and *Grey-wache* and *Schist*, and *Granite* are said, probably, to underlie the magnesian Limestone of Hollywood, pref. vi.

"*Porphry* in unconformable strata of a yellowish and bluish external surface, containing veins of *Jasper*," occur in Cushendall Bay, Dr. D. pref. xiii. What Dr. R. and Mr. D. have said of the Slate, Gneiss, and Granite, in-land, at the NE corner of the County, have been noticed already at page 269, and it remains I think only to mention, that a vein of *Lead* appears in Magee Island, Dr. D. pref. xii.; that *Manganese* is found near Ballycastle, S (I suppose in these strata?) Mr. D. p. 62, and Slieve Aura mountain "has been long supposed to contain Mines," or veins rather, Dr. D. App. p. 33.

Such are the varied substances which the south-eastern, east, and north-eastern borders of Antrim furnish, from what I consider as different parts of the same thick stratum, without being furnished with the means of tracing any invariable law as to their disposition, or thinking that such can be there traced (if such exists) any more than in another stratum of similar properties which I have elsewhere examined, and which nothing but the succession of well marked and different strata (the Lias, &c.) *above it*, could hinder us from concluding to be the very same stratum.

Second—A great *Limestone* stratum, or rather an assemblage of calcareous strata, whose parallel planes are applied on the Marl (or its anomalous beds), and except at the north-east and south-east corners of Antrim county, but little of the Marl remains uncovered thereby, while the surface which the Marl or its imbedded substances make, in the mountains of Down, Louth, Armagh, Monaghan, Tyrone, and

and Derry are probably very variable and considerable, and the same is a proper subject of further elucidation in your Magazine, as a work pretty generally and increasingly read by Geological inquirers. Dr. W. H. Drummond, preface p. viii. gives the following account of the strata above the thin layer of bituminous schist, already mentioned page 272; this is overlaid, says he, "by a *blue Limestone* containing the Star-stone, or vertebræ *Pentacrinites*, *Cornu ammonis*, and *Anomia gryphus*. To this succeeds a stratum of *arenaceous Limestone*, often of a green hue, known in this district by the very appropriate name of Mulatto, from its mixed nature, and the difference of its colour from the snow-white Limestone, by which it is covered. This stratum abounds in *quartz pebbles* (or coarse grains of silex, rather ?) and organic remains, particularly *Belemnites**, *Pectenites Echini*, *Ostracites*, *Cardia*, *Anomia gryphus*, and a substance resembling *Gypsum*, which some suppose to be the *Pinna marina*, so closely conglomerated and united by the arenaceous paste, that they seem in some places to compose almost the whole mass.

"Above the mulatto lies a very thick stratum of *white Limestone*, one of the purest carbonates of Lime, also containing *Belemnites* in abundance, *Cardia* more rarely, with *Flints*, ranging in horizontal lines, and often, where it is traversed by a *dyke*, exhibiting a granular structure like *Marble*. The horizontal lines of its stratification being cut by vertical fissures, it has frequently the appearance of huge quadrangular blocks, artificially built on each other," page ix. And he continues, "One of the most remarkable appearances, which will next arrest the observer's at-

* The *Belemnite* and *Echinus* are often found in flint. The former, when found either in limestone or mulatto, is generally of a yellow, calcareous, sparry texture on the outside, the centre being of the same substance as that in which it is imbedded. From some specimens of the *Echinus* which I broke, it appears, that they are a solid mass of the same material as that in which they lie, and contain no central crystallization: but the place of the shell in flint is marked by a very thin sparry incrustation. In the mulatto the shell is very distinctly preserved; it has become of a sparry texture; is much thicker than that of the urchin, now found in our Seas; has no appearance of an opening having ever been at the top, but of two small orifices near each longitudinal extremity of the base, by which the matter was injected. St. Pierre in his IVth Study of Nature observes, "that many of the cornu ammonis and single-shelled fossils, which from their form have resisted the pressure of the ground, have not ejected their animal matter, but exhibit it within them under the form of crystals, whereas the two-shelled are totally destitute of it." The observation will apply sometimes to the cornu ammonis, not to the Echinus, as far as my observation extends. To the above list, add the *Mytilus* crista galli, the *Dentalium*, *Arco*, *Tellina*, and *Serpula*, found in Collin-Glen by Mr. Templeton."

tention,

tention, is the unconsolidated stratum of mingled *Flints*, *Limestone*, and decomposed *Basalt*, which immediately succeeds. The Limestone is reddish, as if tinged by the oxidated iron of the basalt, the basalt friable as an earthy mould, and the flints shivery, as if they had undergone the action of intense heat. The flints which lie in greatest number on the limestone vary in colour from a light pink to a rosy red, and contain cavities with a yellow impalpable powder, or minute crystals. They are often striped, as if formed by successive depositions, and exhibit manifest traces of *Corals*, *Madrepores*, and other marine exuviæ, which are supposed to have supplied the silicious matter, or to have served as its focus of attraction." "On the beach near Glynn the *Anomia gryphus*, and the vertebræ *Pentacrines* are found in abundance, in *blue Limestone*," p. xi.—"In the Isle of Muck, near Larne, there is a course of *gray Limestone* between the white, according to Mr. D. Stewart," Mr. D. p. 68.—"On the Black mountain, that species denominated *phosphoric Limestone* is met with; likewise at Church Bay in the Isle of Rathlin. On the mountain just mentioned, at the height of about 1100 feet, is a kind of *calcareous Sandstone*, containing a variety of shells, among which some of our native ones may be recognized, as *Arcta glycinaris*, *Pectens*, *Cardium edulis*, and intermixed with the *Mytilus instatus* (figured in White's Natural History of Selbourne), *Ammoniæ serpulæ*, (Mr. Templeman), &c. &c. Mr. D. p. 68.

Blue and white or dove-coloured *Marble* is found on the lands of Ballymurphy, two miles from Belfast; also in Collin Glen, some of its white part being "as transparent as statuary Marble." A fine red Marble inclosing reddish *Flints* in Bamer's Glen near Trummery: a whin dyke far advanced in decomposition to a yellowish or a reddish ochreacous substance, cutting through this and other quarries to the SW, imparts these colours to the limestone near it, making it much harder, finer in the grain, and more crystallized, and which when cut and polished, are nearly equal to the best imported marbles, but they cannot be raised in large blocks, Mr. D. p. 67.

From the circumstance of the upper or *white Limestone* bed* (200 feet thick) never rising wholly above the Sea

* Often mentioned as *Chalk* by writers; and some even who have visited it of late, seem disposed to endeavour to identify it with the Chalk strata of the south of England; a vain attempt surely?—On these accounts I was sorry to read "chalky cliffs" in Mr. D. p. 63; and that the Gypsum far below it "has probably been *Chalk*," p. 73.—Dr. R. says Limestone "as white as chalk," vol. xxxiii. p. 201.

at

at the north-end of the trough, in the distance of 25 miles from Ballycastle to Solomon's Porch (Dr. R. vol. xxxiii. p. 202), and sinking wholly below it, near the mouth of the Bann, I am not surprised, that the previous account of Dr. R. which I had read, of the northern Basaltic Coast, takes no notice of the incumbent coloured and shelly beds of Limestone, above mentioned: the mention however which Dr. R. makes of this stratum, rising as it passes S and inland from Solomon's Porch (vol. xxxiii. p. 202), might have given occasion to observe and describe the whole of this grand calcareous stratum. From Portrush, where the Limestone first emerges from the Sea at the end of the Trough in Antrim, Mr. D. has pretty fully described its edge, to Ballycastle, and thence across the inland mountains to near Newtownglens, and thence along the Coast, within a few miles of it, and of Belfast Bay and the Lagan River, to near Soldier's Town, (App. p. 29), and to Maharlin in the County of Down, Mr. D. p. 63 to 69, 93, &c.; I shall therefore dismiss this stratum for the present: and proceed to

Third—The Great *Basaltic* stratum *resting* on the Limestone last described, whose 16 curious strata or thick beds (together 1200 feet thick, vol. xxxv. p. 376), Dr. R. has exhibited and described in your 33rd vol. p. 166, and of which some further information from Dr. R. will be found in Mr. D.'s App. p. 17, with a separate memoir on the *Zeolites* imbedded in these Basalt strata and the *Ochre* or red decomposing beds interposed between them, App. p. 2. Mr. D.'s account of these strata, pages 38 to 60, will also be perused with interest by Geological readers: at page 60 he mentions *Iron Ores* of different kinds, and thin strata of rich *Hematites* found among the beds of argillaceous Ochre: and *Bog Ore* on the sides of the mountains, and in the valleys between them; and from which sources, probably, the Iron-works that were formerly used N of Randalstown, were supplied with Ore, p. 473; and the Iron (Furnace) Foundery on the shore of Lough Neagh in Derry, by strata of Iron Ore stretching from that place to Slieve Gallon Mountain, a distance of ten miles, (in this Basalt?) according to Mr. Barton, p. 140 and 144.

Pozzolano of good quality has been worked from these ochreaceous beds in Rathlin Isle, Mr. D. p. 61, and Dr. R. App. 12. *Fullers' Earth*, at the Falls of Belfast, Bamer's Glen, p. 62 and 67; *Soap-stone* of a purple colour, in a large stratum SW of Larne, p. 61; *Tripoli* of a rough kind on the SW of Agnew's hill, p. 62; *French-Chalk* near the Gobbins

Gobbins in Magee Isle, p. 62: and *Wood Coal* or compressed bituminated Wood, usually in thin seams between the basalt beds, at Mount-Druid near Ballintoy, p. 87, at Killymorris near the centre of the County, at Limineagh, also near the E shore of Lough Neagh (between Ballinderry and Crumlin), and near Portmore, p. 89, at which last place two beds of 25 feet thick, a third 9 feet, and a fourth still lower was penetrated 18 inches by the boreing rods, at 80 yards deep, before the operation was discontinued, p. 90: and at Bengore-head, in a considerable stratum between, two rows of basaltic pillars! p. 90. Note.

The shrinking and opening of fissures and caverns in the Limestone, beneath these Basalts (in common with all thick calcareous strata which I ever saw), which the water-swallows at Red Hall and near Kilwalter (p. 71) serve to illustrate, may well account for the sinking of the Basaltic surface into *Funnel-shaped hollows**, at Broom-mount in Soldier's Town and elsewhere, mentioned App. p. 112; but where it was by no means necessary, to resort to the improbable suppositions of "the softening and carrying away of some understratum, probably Limestone, by the action of subterraneous running waters," to account for these local, and in some districts very common depressions of the surface: and which seem to have nothing in common with the decomposing cores and semi-spherically-shaped cavities † left on the surface of Basalt,

* Among the numerous facts collected, and further attainable, towards my proposed *Mineral History* of Derbyshire (should an adequate interest and encouragement arise and offer, to render it prudent on my part ever to resume it), which could not find a place in the published Report to the Board of Agriculture, the several conical depressions in the 3rd Toadstone (or Basalt) near Water-Swallows in Fairfield, owing to the shrinking of the thick 4th Limestone beneath, remain to be mentioned, as instances similar to those in Antrim. A depression or elliptical Sankum or Basin of small extent and depth, on the 1st Grit Rock SW of Overton Hall, lately presented itself to my notice, in surveying and levelling in the Fields in that part for Sir Joseph Bank's large Mineral Maps and Sections which I have in hand, and probably indicates a cavern or large shake-hole in the 1st Lime Rock beneath, into which this thick grit-stone Rock has become locally depressed. Hell-Kettles S of Darlington in Durham are, doubtless, two sunk places of the upper clayey stratum, into the shrunk magnesian Lime Rock beneath. Nor is it uncommon, owing to the unequal contraction of the lower calcareous beds (where there is no superincumbent stratum) to find depressions in calcareous soils, as may be seen on a grand scale about Stanstead NE of Brighton, in the upper Chalk; in Norfolk near to Mr. Colhourn's former residence: on a smaller scale on the Chalk Hills SW of Wendover, Bucks.: and even in Gypseous tracks, according to the 1st Edit. of Jameson's "Geognosy," p. 34 and 172.

† The several Rock Basins, and some of the Stone Chairs on the 1st Grit Rock, where exposed in blocks, in Derbyshire, seem owing wholly or in great part, to decomposed or loosened Lums or Nests of Mica plates, such as are noticed in my Report, vol. i. p. 466.

in

in the bed of Glenarm River, mentioned by Dr. D. pref. xii.

Dr. W. H. Drummond's description of these strata and their imbedded contents, pref. p. x. is as follows: "Over-topping all (the Limestone strata) is the great stratification of *Trap*, with its subordinate divisions of *Greenstone*, *Porphry-slate*, *Trap-Tuffa*, and *Amygdaloid*. The solid Trap and the Amygdaloid alternate, as may be distinctly seen at the Knockagh, the former showing traces of incipient columnarity, the latter less rent into (by) fissures, often very friable, and indented at its junction with the Trap; thickly studded with *Zeolite*, and of a dark gray, brown, or reddish colour. It would require frequent minute examinations to ascertain the order in which the different numerous strata of this formation succeed each other. There is also a stratum of an ochreous vermillion *red substance* which may be seen at the base of the precipice of the Cave Hill, but in much greater beauty and extent at Murlogh and the Giant's Causeway. The *Porphry slate*, which may be easily distinguished by its slaty fracture, is ornamented with small topaz-coloured crystals of *Chrysolite* or *Olivin*. Small brilliant crystals like *Sapphires*, and opake crystals of *Shorl*, are found in some varieties of the Trap; that of Fair-head, which is so coarse as to resemble Granite, contains *Augite*. The vesicles of the amygdaloid are almond-shaped, tubular, quadrangular, and a series of them is often connected together. They are supposed to have been formed by air-bubbles during the deposition of the strata, and to have been afterwards filled or lined by percolation with the matter by which they are now occupied. This is, *Steatites*, *calcareous Spar*, *Calcedony*, *Opal* or *Zeolite*: the last is very prevalent: it is sometimes cubical, often stelliform, and in the beauty, delicacy, and the arrangement of its crystals, vies with the Thistles' down. As the character of Basaltic or Whinstone Mountains, the flatz-trap formation of Werner, are too obvious to be mistaken, the description of one may serve for the whole. On one side they generally present a steep precipice, and on the other fall away with a gradual slope*. They are flat at the summit, whence they are denominated Tabular."

A bed of prismatic Basalt at Portrush and the Skerrie Islands, is full of *Belemnites* and of *Pectenites*, and above all, of *Cornua Ammonis*, dispersed through the whole mass,

* What *stratified* Mountains, in denudated districts in particular, do not present these Characters? more or less perfectly, as their upper stratum is permanent or otherwise? that is, will or will not endure the weather.

vol.

vol. xxxv. p. 370, Mr. D. p. 53, and App. p. 36: Dr. R. seems, however, only to mention the Ammonites: and Dr. D. says, pref. p. xv. "At Portrush, the *Chert*, *Petrosilex*, or *Silicious Basalt*, abounding with impressions of the Cornua Ammonis (many of which are pyritous, and emulate the splendour of gold) rises to puzzle the Geologist."

Of the *Whynn Dykes* or *Veins* of Basalt which intersect and branch off in northern and eastern directions from this great Basaltic Area, I must at present say nothing, but refer to Dr. R.'s valuable paper on this subject in your 35th volume, p. 364.

It will be necessary here, to say something more particularly as to the limits of the Basaltic strata, and their position, preparatory to assigning the Coal-series a place *upon* them, both to show the grounds of my proceeding therein, and to furnish what clues I am able to future observers, who may, and I hope ere long will undertake, the decision of the important questions stated in page 267. From Solomon's Porch NW of Coleraine in Derry to Ballycastle in Antrim, the N end of the Basaltic *Trough* occupies the cliffs of the Ocean; from Ballycastle* to the heights above Newtownglens, its NE irregular corner, crosses the mountains: from the last mentioned place round the coast of the Ocean, the Lough, and the banks of the River Lagan, at a somewhat greater distance than that of the Limestone edge, the eastern Basaltic edge is to be traced, till it crosses the Lagan near Moira (Mr. D. p. 39), but turns then again suddenly to the E (as the Limestone also did, I expect) and proceeds in Down County, "considerably to the Eastward of Lisburn," Mr. D. p. 38, Note: this deep indent into the edge of Limestone and Basalt strata being occasioned by the *excavation* of the Lagan valley, just as they are indented on the west side in Derry by the Mayola excavation (which Dr. R. has so well described, vol. xxxiii. p. 202), except that here Red Marl is exposed by the excavation, and there Schistus which has occupied its place, in "a little system." From Dr. Hamilton's Map, referred to by Mr. D. in a note, p. 38, leaving the basaltic bounds against Down County undefined, and from the obscurity of the descriptions that I have read of the same, in Down and Armagh and Tyrone: I am led to suppose, that considerable accumulations of *Alluvia* are there lodged and conceal

* The detached Basaltic Cliff of Fairhead NE of Ballycastle will be mentioned further on, as a severed and sunk corner of the Basalt with Coal-measures on it.

most

most of the strata *; but for which, I should not despair if on the spot, of tracing the eastern edge of the Basaltic trough, from where Mr. D. leaves it E of Lisburn, in a S or SW direction to the SE coast of Down, or that of Louth: to find again its western edge on that Coast, and trace it thence in a NW or NNW direction to Slieve-Gallon Mountain W of Desmartin in Derry, where Dr. R. satisfactorily describes its edge, vol. xxxiii. p. 202, and App. 23, and thence NNW to Solomon's Porch at the NW corner, where I began. It is true, Dr. R. (App. p. 22) mentions a strip of Basalt about three miles broad, extending near to the middle of Armagh County at Market-hill and Gosford-Castle, in such terms, as might have led me to suppose, that white limestone appeared from under the sides of this projecting horn of Basalt; had not Mr. D. p. 373, informed us, that an official document of the Irish Parliament states, that "from Blackwater town (down the Blackwater River) to Lough Neagh, and from thence again up the River Bann, and along the Canal to Newry (an extent of nearly 30 miles) there is *no limestone whatever*;" although the line of navigation from Lough Neagh to Newry must twice have crossed the great Limestone basset, had not its unbroken plane, in all this length, laid deep buried under Basalt, with Gravel locally distributed on it, as the "whynstones on the surface," Mr. D. p. 39, and the "field-stones," Dr. R. App. p. 22, give room to suppose; but when Dr. R. returns northward (not southward, p. 23) in describing the western edge of his Basaltic area, and says, it "crosses Lough Neagh diagonally, catches the Derry shore not far from Ballyronan; the Basalt is found incumbent on white limestone at Spring Hill." A difficulty arises, and I am unable to follow him, for want of any Map which shows either, the two last places or Magheralin, mentioned in the preceding page (and p. 277 herein); or to gain satisfaction, as to *whether Limestone any where appears on the shores of Lough Neagh?* and under what circumstances? I should suppose it does not, both from what Dr. D. says p. 159, as well as the document above quoted, whose object was, to show, the necessity of a Canal to the Blackwater Navigation at the Town of Moy, which, were it "opened from Armagh, it must necessarily go through Lands in that vicinity,

* Since the above was written, Dr. Richardson informs us (Agricultural Magazine, vol. x. p. 135) that "on the south side of Lough Neagh, the country is for ten miles long and six broad a deep flow bog, with a number of islands" thinly scattered over it, called Derrys; are these islands composed of basalt? or of grit stone, shale, &c. belonging to the coal-measures?

nity, containing inexhaustible quantities of Limestone, which could be conveyed by (Antrim, &c) Boats, returning from Armagh." The shores of Lough Neagh appear also to be flat on all sides, I understand, so that lowering its water 15 inches, would probably regain 1700 acres or more to the Land, from a Lake of 60,000 acres, now 45 feet deep in the middle, and pretty gradually shallowing to all its extremities, Mr. D. p. 101: its deepest part being one foot above the level of the Sea, as appears by the levels of the Belfast and Lough Neagh Canal, Mr. D. p. 365, although in p. 103, its bottom is said to be three feet lower in some places than the surface of the Sea at the outlet, by the course of the Bann, obstructed by solid dams of Basaltic Rocks. These circumstances will, I trust, show the propriety, of my considering the bottom of the great Trough in the NE of Ireland to dip *southward*, rather than northward as Dr. R. at page 201 and 202 of your 33d vol. and page 376 vol. xxxv. seems to represent; but which it is plain he could not mean, as at pages 105 and 107 of vol. xxxiii. and elsewhere, he represents the strata as rising towards the north: the word "section," line three from the bottom of p. 201, vol. xxxiii., being inaptly applied to the *edges** of the strata, which edges without doubt *rise* southwardly, for some miles from the north Coast, as stated p. 376; owing, doubtless, to the E and W dip towards the bottom of the trough, increasing, through that distance, and producing twisted or winding surfaces, rather than mathematical planes in the Limestone and other strata; for the water of Lough Neagh in its deepest part, probably, I think, rests on strata of Basalt, that are several hundred feet elevated above the sea on the north of Coleraine.

[To be continued.]

XLI. *Experiments on the Strength of Men and Horses in moving Machines. By M.* SCHULZE†.

THOSE who have had occasion to construct machines intended to be moved by men or animals, are sufficiently aware how important it is to be acquainted with the quantity of motion that can be attributed to either of them, in order to estimate with accuracy the effect which it is proposed to obtain by the machine. It is well known that the arrangement of the whole depends entirely on the ratio of

* A phraseology too common with some Geologists.

† Translated from the Memoirs of the Royal Academy of Sciences of Berlin for 1783, by T. S. Evans.

of the velocity of the motive force to the resistance. This was the reason that long ago induced them to take the trouble of determining the strength as well as velocity exerted by men and animals when they are made to move machinery; and the results they obtained, which have been commonly made use of in computing the effect of machines, are, that men exert from 27 to 30 lbs. with a velocity of from $1\frac{1}{2}$ to 2 feet per second; and that a horse has about seven times more strength than a man, with a velocity of from 4 to 6 feet per second.

These are the data which we have been obliged to use whenever it became necessary to compute the effect of a machine moved by men or horses. It is evident that the force must be diminished when the velocity is increased, and *vice versâ:* but we are not yet certain of the method of finding the ratio of the diminution or augmentation of this force to the velocity. Euler has given us two different formulæ to compute this ratio; but no one has hitherto attempted to verify by experiment, which of them is to be preferred, although they differ very considerably from each other. If we put P for the absolute force which takes place when we simply consider equilibrium, C the absolute velocity which takes place when the man or animal moves freely and without being overcome by the resistance; p the relative force, and c the corresponding velocity, we have by the first of these formulæ,

$$p = P\left(1 - \frac{c}{C}\right)^2$$

Whereas the second gives us

$$p = P\left(1 - \frac{c^2}{C^2}\right).$$

As I am obliged now more than ever to attend to a number of machines, and to compute their effect, it therefore concerns me very much to know exactly in what manner to estimate, compare, and fix the strength and velocity of men and animals which are used for moving various machines proper for different purposes.

With this view I made with considerable care the experiments I am now about to detail; which of course would have been very expensive, had it not been for some facilities which other persons may not possess.

To make the experiments on human strength, I took promiscuously 20 men of different sizes and constitutions, whom I measured and weighed; the result of which is given in the following Table:

TABLE.

Order	Size.			Weight.	Order	Size.			Weight.
1	5′	3″	4‴	122	11	5′	9″	7‴	132
2	5	2	3	134	12	5	1	4	157
3	5	7	2	165	13	5	3	2	175
4	5	5	0	131	14	5	4	1	117
5	5	11	2	177	15	5	10	8	192
6	6	0	4	158	16	5	0	3	133
7	5	8	3	180	17	4	11	2	147
8	5	2	1	117	18	5	3	9	124
9	5	4	8	140	19	5	6	0	163
10	5	0	4	126	20	5	10	1	181

To find the strength that each of these men might exert to raise a weight vertically, I made the following experiments:

I took various weights increasing by 10 lbs. from 150 lbs. up to 250 lbs.; all these weights were of lead having circular and equal bases. To use them with success in the proposed experiments I had at the same time a kind of bench made, in the middle of which was a hole of the same size as the base of my weights: this hole was shut by a circular cover when pressed against the bench; at other times it was kept at about the distance of a foot and a half above the bench, by means of a spring and some iron bars. To prevent the weight with which this cover was loaded during the experiment from forcing down the cover, lower than the level of the surface of the bench, I had several grooves made in the four iron bars, which sustained the cover, and which at the same time served to hold up the cover at any height where it might arrive by the pressure of the springs as soon as the pressure of the weight ceased.

After having laid the 150 lbs. weight on the cover, and the other weights in succession increasing by 10 lbs. up to 250 lbs. I made the following experiments with the men whose size and weight are given above, by making them lift up the weights as vertically as possible all at once, and by observing the height to which they were able to lift them. The following Table gives the heights observed for the different weights marked at the head of the Table.

TABLE.

TABLE.

	150		160		170		180		190		200		210		220		230		240		250	
	″	‴	″	‴	″	‴	″	‴	″	‴	″	‴	″	‴								
1	7	9	6	4	4	11	4	4	3	8	2	8	1	1								
2	7	10	6	6	5	7	4	7	3	11	2	5	0	5	″	‴	″	‴				
3	7	9	7	3	6	5	5	9	4	11	4	0	3	0	1	7	0	3	″	‴		
4	8	3	7	6	7	2	5	10	5	3	4	7	4	0	3	8	3	1	1	4		
5	12	4	11	1	9	7	8	5	7	10	7	1	5	10	4	7	3	2	1	3		
6	14	5	14	0	13	5	12	8	11	5	10	1	8	6	6	6	4	1	0	1		
7	12	11	11	3	10	5	9	3	8	1	6	9	5	3	3	8	1	11	0	2		
8	11	9	10	2	9	4	8	11	8	1	6	11	5	10	5	1	3	2	1	0		
9	9	5	8	3	7	1	5	6	4	1	2	9	1	3								
10	8	1	6	5	4	7	3	9	2	5	1	7	0	4								

This Table proves to us that the size of the men employed to raise the weights vertically has considerable influence on the height to which they brought the same weight. We find also by this that the height diminishes in a much more considerable ratio than the weight increases ; and we may therefore conclude, that it is advantageous to employ large men when it becomes necessary to draw vertically from below upwards : and on the contrary, it is more advantageous to employ men of a considerable weight, when it is required to lift up loads by means of a pulley about which a cord passes, that the workmen draw in a vertical direction, from above downwards. To find the absolute strength of these men in a horizontal direction I took the following method.

Having fixed over an open pit a brass pulley extremely well made, of 15 inches diameter, whose axis, made of well polished steel to diminish the friction, was $\frac{3}{4}$ inch in diameter ; I passed over this pulley a silk cord worked with care to give it both the necessary strength and flexibility. One of the ends of this cord carried a hook to hang a weight to it which hung vertically in the pit, whilst the other end was held by one of the 20 men, who in the first order of the following experiments made it pass above his shoulders ; instead of which, in the second, he simply held it by his hands.

I had taken the precaution to construct this in such a manner that the pulley might be raised or lowered at pleasure, in order to keep the end of the cord held by the man always in a horizontal direction, according as the man was tall or short, and exerted his strength in any given direction.

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I had made the necessary arrangements so as to be able to load successively the basin of a balance which I had attached to the hook at the end of the cord which descended into the pit, whilst the man who held the other end of this cord employed all his strength without advancing or receding a single inch.

The following Table gives the weights placed in the basin when the workmen were obliged to give up, having no longer sufficient strength to sustain the pressure occasioned by the weight. To proceed with certainty, I increased the weight each time by five pounds, beginning from 60, and I took the precaution to make this augmentation in equal intervals of time, having always precisely a space of 10 seconds between them. The result of these observations repeated several days in succession, is contained in the following Table.

When the cord passed over the shoulders of the workmen:

Order	lbs.	Order	lbs.	Order	lbs.	Order	lbs.
1	95	6	100	11	95	16	95
2	105	7	115	12	100	17	100
3	110	8	105	13	110	18	90
4	100	9	95	14	90	19	100
5	105	10	90	15	110	20	105

When the cord was simply held before the man:

Order	lbs.	Order	lbs.	Order	lbs.	Order	lbs.
1	90	6	100	11	90	16	90
2	105	7	110	12	90	17	90
3	105	8	100	13	100	18	85
4	90	9	90	14	85	19	100
5	95	10	85	15	105	20	100

These two Tables show that men have less power in drawing a cord before them than when they make it pass over their shoulders: it shows us also that the largest men have not always the greatest strength to hold, or to draw in a horizontal direction, by means of a cord. To obtain the absolute velocity of these 20 men, I proceeded as follows:

Having measured very exactly a distance of 12000 Rhinland feet in a plain nearly level, I caused these 20 men to march

march with a good pace but without running, and so as to continue during the space of four or five hours; the following is the time employed in describing this space, with the velocity resulting for each of them.

Order	Time.	Veloc.	Order	Time.	Veloc.	Order	Time.	Veloc.
1	40 18	4 94	8	40· 9	4·99	15	36·17	5·51
2	41·12	4·85	9	40·20	4·90	16	41·28	4 82
3	39 8	5·55	10	40 51	4 90	17	42·25	4·71
4	39 40	5 04	11	36·17	5·51	18	40·19	4·98
5	34 19	5 83	12	38·11	5 24	19	39·57	5·01
6	35·11	5 68	13	38· 5	5 25	20	37·51	5·29
7	38 7	5·25	14	37· 1	5·40			

It is necessary to mention with regard to these experiments, that I took care to place at certain distances persons in whom I could place confidence, in order to observe whether these men marched uniformly and sufficiently quick, without running.

Having thus obtained, not only the absolute force, but the absolute velocity also, of several men, I took the following method to determine their relative force.

I made use of a machine composed of two large cylinders of very hard marble, which turned round a vertical cylinder of wood, and moved by a horse, which described in his march a circle of 10 Rhinland feet. This machine appeared to me the most proper to make the following experiments, which serve to determine the relative strength that the men had employed to move this machine, and which I use hereafter, to determine which of Euler's two formulæ ought to be preferred.

To obtain this relative force, I took here the same pulley which served me in the preceding experiments, by applying a cord to the vertical cylinder of wood, and attaching to the other end of this cord which entered into an open pit a sufficient weight to give successively to the machine different velocities.

Having applied in this manner a weight of 215 lbs., the machine acquired a motion, which after being reduced to an uniform motion, taking into account the acceleration of the weight, of the friction, and of the stiffness of the cord, gave 2·41 feet velocity; and having applied in the same manner a weight of 220 lbs. the resulting uniform motion gave a velocity of 2·47 feet. I only mention these two limits because they serve as a comparison with what immediately

mediately follows: I began these experiments with a weight of 100 lbs. and increased it by 5 every time from that number up to 400 lbs.

I made this machine move by the seven first of my workmen, placing them in such a way that their direction remained almost always perpendicular to the arm on which was attached the cord which passed over their shoulders in an almost horizontal direction.

Thus situated, they made 281 turns with this machine in two hours, which gave for their relative velocity $c = 2{\cdot}45$ feet per second. We have also the absolute force, or P, from these 7 men, by the above Table $= 730$ lbs.: and their absolute velocity or $C = 5{\cdot}30$ feet.

Therefore, by substituting these values in the first formula, we find the relative force $p = 205$ lbs. which agrees very well with what we have just found above.

If instead of this first formula the second be taken, it gives $p = 153$ lbs. which is far too little.

By this it is evident, that the first of Euler's two formulæ is to be preferred in all respects. I have also made a great number of combinations, and I almost always found the same effect.

Dividing the 205 lbs. which we have just found by 7 the number of workmen, we get 29 lbs. for the relative force with 2·45 feet relative velocity for each man, which is rather more than the values commonly adopted in the computation of machinery. A number of other observations on different machines, which I intend to relate another time, have given me the same result; that is to say, we must value the mean human strength at 29 or 30 lbs. with a velocity of $2\frac{1}{2}$ feet per second.

To obtain the ratio of the strength of a horse to that of a man, I had the same machine moved by a horse without altering any thing; and I found by ten different horses which I used successively, that a horse makes 603 turns in 2 hours instead of 281: therefore, by supposing the static motion of a horse 7 times greater than that of a man, we find that the former has 5·3 feet per second of velocity.

By this it is evident, that the effect of a horse is 14 times greater than that of a man, or, which amounts to the same thing, 14 men must be used instead of 1 horse. Hence it appears, that it is much more advantageous to employ horses than men in moving machines, if other reasons did not require us to prefer men.

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I have also made a number of other interesting observations on horses and oxen, which are likewise used in moving machines: but as I am now waiting for observations of this kind, which other persons are making according to my plan, I shall reserve what I have to say respecting them for a second memoir.

XLII. *A Rejoinder to a Paper published in the Philosophical Magazine, by Dr.* Marcet, *on the Animal Fluids.* *By* George Pearson, *M.D. F.R.S., &c.*

To Mr. Tilloch.

Sir, By a severe accident I have been prevented from writing the paper which I proposed in my Communication honourably inserted in your Journal for January last. Meanwhile an answer to that Communication has been published by Dr. Marcet*.

Before I redeem my pledge of offering some remarks on Dr. Marcet's Memoir, I feel myself called upon by what I consider to be the true interests of science to reply to his intervening answer. This gentleman cannot be more averse from polemical writing than I am, nor have more cogent motives of private advantage by being otherwise employed; but unless I were to avail myself of the plea of a celebrated philosopher, who asserted that his regard for truth was so great that he would not part with it lest it should be ill treated by mankind, I have no option consistently with public duty. The feelings of either party must however regulate their future conduct. For myself, I can only promise that I shall not consider it as a point of honour, to contend for the last word.

In the answer which has been addressed to me, Dr. Marcet has set forth evidence from his memoir, still under examination, to maintain that soda in an uncombined state, and not potash, exists in the animal fluids; as I trust I have legitimately proved according to facts hitherto discovered. As my honourable Opponent has still not contravened the most decisive parts of the evidence in support of my allegations, I am spared the pains of again displaying it; so that I have only to comment on the evidence he brings forward in justification. In my remarks, perhaps, I cannot entirely avoid repetition of objections already produced.

The first kind of proof that soda and not potash is present, again

* See the Philosophical Magazine for February last.

again asserted by my adversary, is from the figure of crystals. I have to remark, in addition to my former observations, that their forms alone rarely or never, even when perceivable with the unassisted organ of vision, do *singly* denote unequivocal properties; and when not perceivable without the medium of glasses, we know from past experience the figures are to be considered as still more equivocal, I might say deceptive. If these crystalline forms are now admitted as justly distinguishing properties of certain substances, it is in consequence of repeated observation on larger quantities by direct vision,—"quæ sint oculis subjecta fidelibus,"—but even then not without concomitant other well ascertained properties.

Secondly—Great dependence seems to be placed on the acetate produced by combining acetic acid with the saline matter afforded by incineration. This was said to be acetate of soda, which dissolved in alcohol, while potash was found in the residue left undissolved by the alcohol. I have searched the pages of the memoir under examination again and again, for the evidence in support of this allegation; but here, and on many other occasions, is a mere assertion, except a partial support from the serum of the blood, as will be seen hereafter. For, 1. With regard to the saline matter of the fluid of the *spina bifida* I find these words: "the alcoholic solution being decanted off and evaporated to dryness, a residue *supposed to consist of acetate of soda was obtained.*" Here no mention is made either of an experiment to prove whether the acetate was that of soda or of potash, but it was *supposed* to be acetate of soda. As to the undissolved matter containing potash, there is not that I can find even a word written. This too has been *supposed.* 2. With regard to the second fluid examined, that of *hydrocephalus internus,* we are told "the analysis was conducted in the same manner as in the former:"—of course the existence of soda in the alcohol and of potash undissolved are not proved, but I presume here also *supposed.* 3. In the other animal fluids, viz. of ascites, of hydrothorax, and hydrops pericardii, as well as subsequently of the hydrocele; of the hydatids, of the thyroid gland, and of a tumour of the chest, no such experiment as that of compounding an acetate is mentioned. 4. In the experiments, however, on the saline matter of the serum of the blood, an acetate was compounded which dissolved in alcohol, the words of the author being, "the alcoholic residue *contrary to my expectations exhibited* traces of potash, both by means of tartaric acid and oxymuriate of platina."

This,

This, as far as I can find, is the sole experiment with acetic acid and alcohol, related by the author to determine the kind of alkali present, although the assertion is made of the animal fluids generally. But although the assertion be not proved, it may be worth while to consider what, or whether any thing, is proved by these experiments? They prove that potash was present, because there was a precipitate with tartaric acid, but nothing more—there is no proof that it was in the state of muriate, as asserted. It perhaps will be said that these experiments prove, that this "alcoholic residue" contains also acetate of soda; "for the same residue treated with nitric acid was almost entirely resolved into rhomboidal crystals, amongst which I was unable to detect any distinct prisms." Now, I have already expressed my want of confidence in the figure of minute crystals *singly* as evidence; especially, seen through glasses: and here, I presume, is a decisive instance of their fallacy; for potash being proved to be present, as already said by Dr. Marcet, united to muriatic acid, it must have afforded cubes, if reliance can be placed on forms; but no such cubes were seen. A further objection occurs to my mind in this experiment. I apprehend it is quite as likely to be true that alcohol will dissolve a small proportion of muriate of soda, as according to Dr. Marcet it does of muriate of potash. This being the case, the "alcoholic residue" ought to have afforded cubes of muriate of soda as well as of muriate of potash. The process under examination requires further animadversion :—on the remaining part of it "potash was easily discoverable in the residue insoluble in alcohol, which residue had now lost its deliquescent quality." That potash in a combined state was present I admit may be inferred, but I say confidently, there is no proof that it was united to muriatic acid. It is not incumbent on me, but on the Affirmer, to show with what it is combined. I think it right to notice another unsatisfactory part of the process before me. It is said a concentrated solution of the saline mass in question did not distinctly indicate potash by oxymuriate of platina, but did by tartaric acid. Subsequently, however, we are told that the dissoluble as well as the indissoluble residue of the acetous compound in alcohol readily denoted the presence of potash to the oxymuriate of platina as well as to tartaric acid. To my apprehension, I own this account only shows that the quantities were too minute for distinct observation of facts. How all ambiguity might have been removed, I have taken the liberty of proposing in commenting on this process in my former

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Communication to your Journal, p. 69, l. 15. for January last. On that occasion I expressed my doubt whether or not the acetate of soda be dissoluble in alcohol, but I deferred to the authority of experiment. Here my learned friend exultingly construes these phrases of doubt, *two palpable errors*, and seems to triumph—"a hit, a hit, my Lord, a very palpable hit."—No: there is no error in this case, Dr. Marcet; according to the *English* meaning of the terms used. To make the utmost of these asserted errors, I am also charged with no less than three times repeating them; as if the propriety of writing was absolutely limited to the number of times an assertion should be delivered. At this time however, without the slightest uneasy sensation, I say that acetate of soda is a deliquescent salt, and dissoluble in alcohol; for I have performed the necessary experiment; not indeed with "half a grain and a watch-glass," but with 50 grains. The truth is, I had not leisure, little time as was required, when I wrote my Communication, to make the experiment; but as, on inquiry of a friend most likely to be informed, I found he was ignorant; as on just looking into two valuable books, Aikin's Dictionary, and Thomson's Elementary Work, one said the acetate of soda was a permanent, and the other a deliquescent salt; and as in my collection of specimens there was a permanent crystallized salt labelled by my Assistant, Acetate of Soda; I thought it best to leave the matter as doubtful, although I own I inclined to the contrary opinion of that which is now I believe the truth. Dr. M. may call this a *palpable error*, if he pleases—he will hurt nobody but himself by the phrase. The main proof is hereby not affected; for the fact now ascertained against my doubtful opinion is only a collateral evidence on either side.

Thirdly—Another source of evidence against me is that potash combined "was proved by the tests of oxymuriate of platina and tartaric acid." The just inference has been already proposed; but I will barely remark that the experiment does not prove that soda was or was not present.

As to any other proofs, they have been already minutely examined in my former Reply, or have been answered in this: but I entreat the indulgence of being allowed to make two or three further remarks. 1. On the fluid of the spina bifida, of the thorax, and of the pericardium, the tartaric acid was not employed at all. Of these fluids the analysis in general was very partial. 2. Of the alkaline matter of the hydrocephalus fluid, the experiment must be unsatisfactory by the tests, on account of the impracticability of entirely

entirely separating the two alkalies from one another in such minute quantities as were obtained; and if the separation were not effected, as the two fixed alkalies are affirmed to exist, the test by tartaric acid must have produced soda-tartrate of potash,—consequently the inference of the adverse party cannot be just.

Having as briefly as I deemed proper, commented on the opposing evidence, and set forth in a different light my own, I must pay due respect to the other parts of the ingenious Answerer's paper. If it shall appear that the only difference in the results of the inquiries by the two parties worth particular notice is with respect to the alkaline matter, I submit to the chemical public, whether or not Dr. M. could with common discretion have published his memoir without a reference to his predecessor, as he observes he could have done with propriety; and especially as he owns he was directed to the alkaline impregnation by my paper and conversations. Dr. M. complains that he is at a loss to understand my meaning, and is much embarrassed by my obscure and inaccurate manner of writing. I am grieved that my learned friend should experience these difficulties; but as I have not heard similar complaints from others, I may, perhaps, not indecorously venture to say that his claim to judgement of propriety and perspicuity in English is somewhat doubtful.

The ingenious Opponent cannot agree with me that substances and properties of substances are discoverable by operating upon large, which cannot be discovered with smaller quantities. I really thought the proposition so obviously true that illustration is needless. Heaps of illustrative examples in nature occur to my mind while I am writing, both in the department of chemistry and physiology. If arsenous acid, muriate of soda, or of sulphuric acid, be dissolved in the proportion of one part to 100 equal parts of water, they will be discoverable by well known reagents; but if the proportion of water be increased more and more, the indication of their existence will become less and less distinct; and at last they will be no longer perceivable, although it be known that they exist: or, if I take certain fractional designated parts of any given weight of these substances, they will elude manifestation by any means hitherto known. On this principle of division and diffusion, the most deleterious poisons become innoxious by the minuteness of the quantity applied to the human constitution. Hence atmospheric air containing fen miasmata, plague contagion, or variolous matter, &c. is applied

plied with impunity to the human constitution. A pound of blood of a glandered horse transfused into a healthful horse cannot excite disease, but as much blood as can be transfused from two glandered horses into one horse can excite the disease of glanders. Sugar, alkali*, &c. may exist in the blood, but not be discoverable by any known re-agent on account of the small proportion of them existing in the blood at any given time, as I humbly reason, and not on account of an hypothetical new channel—a sort of north-west passage—from the stomach to the urinary bladder. In the case of waters the proportion is so minute of various impregnating substances, that unless very large bulks be used they must escape detection. The great masters have accordingly employed such large bulks. Margraaf (*Opuscules Chymiques*, t. ii. p. 8.) did not evaporate 100 drops of snow or rain water in a watch-glass capsule, like some modern microscopic chemists, but he operated upon 100 quart measures of snow-water, in which he was able to find only 60 grains of carbonate of lime, a few grains of muriate of soda, and traces of nitrous acid. I had the advantage of making my juvenile efforts to perform several chemical exercises under that great master, Professor Black. Among other precepts treasured in the tablet of my memory for more than 30 years, was that of employing large bulks of mineral waters; and of all other things in which there was a probability of minute proportions being present. The reasons of Dr. Black for not practising according to this rule in the instance of the analysis mentioned, I cannot pretend to assign; but it seems probable that he was in possession of only a small quantity of the material. As to the magnitude of the masses of matter required, it is impossible to specify them; but it is obvious that analysis must fail to develop certain substances, on account of the minute proportion to other things with which they are mixed not being susceptible of being made evident to the senses; and, in consequence, by a due larger proportion they may be rendered sensible. Hence, perhaps, it is that we are ignorant of many of the properties of light, calorific, electricity, of infectious and contagious matters, &c.

It is argued against me, that "the chemical properties

* In Dr. Rollo's work on Diabetes, I have related an experiment in which potash was taken in such quantity that the urine became so impregnated as to afford a precipitate of supertartrate on dropping into it tartaric acid; at the same time the blood did not indicate a trace of alkali; owing, as I concluded, to the small proportion of alkali to the blood.

which

which belong to a particle of matter belong to the whole mountain of the same substance." True; but I know nothing of the properties of substances but by means of the external senses (this indeed is an axiom); and unless the particle be of a due magnitude, my organs of sense cannot inform me in its properties. My honourable adversary talks of the advantages of a small scale of operations in the points of œconomy and convenience. Granted—but these are minor considerations indeed, to the acquaintance with properties or acquirement of knowledge. When Dr. Marcet also speaks of the advantage in point of accuracy, I protest against it for reasons above explained. It is further represented that there is a degree of "*neatness* gained by reducing the scale of operations." I own I have difficulty to conceive a just sense in which this term may be employed on this occasion. Does it mean the avoiding extraneous things occurring in operations? If so, I cannot separate it from *accuracy;* and as it is seldom practicable to operate without meeting with some extraneous matter, or "dirt," it appears to me that many of those old chemists who are reproached for mentioning "a little dirt" in their results are more accurate than those modern chemists who make up a "*neat*" tabular exhibition of the constituents of substances in centesimal quantities which they have never weighed, and even of which substances there is a palpable deficiency of proof. If by *neatness* be meant the instruments employed, it would be as injudicious to prefer neatness to knowledge, as euphony of style to perspicuity.

A proud list is displayed of discoveries achieved by microscopic experiments, or on small masses of matter; but that was needless. I never disallowed the utility of such experiments. My plain answer is this—that for certain purposes all the knowledge that is wanted is attainable and most easily by operations on the small scale—that such is the nature of our present instruments, that it is only practicable to work on small quantities of some kinds of matter—that on almost all occasions it is advantageous to commence an intended perfect investigation with experiments on small masses, in order to enable the mind to invent subsequent experiments and perform decisive operations on large quantities. As to the successful practices referred to, they only manifest that much may be accomplished with inferior means; but it is demonstrable that the same persons could have attained infinitely more by superior instruments and in the more favourable circum-

stances

stances of adequate quantities. In chemistry, I consider illustration by examples to be superfluous. Physic furnishes new illustrations analogous to the question under discussion. Sydenham without chemistry, with seemingly little of anatomy and physiology, as well as of natural history, has meritedly the credit of one of the greatest Improvers:—if he could acquire so much without these auxiliaries, it appears according to all reason that by means of them much more would have been achieved. I might, however, exemplify the advantages for which I am contending by the conduct of Dr. Marcet himself. It appears that he performed the analysis of two animal fluids, of the component ingredients of which he has given an account, to the one hundredth part of a grain, without finding potash in any state. Subsequently, however, this alkali was detected in other animal fluids, the author's attention being directed, as he is pleased to say, by my published paper, and by my conversations. Whether otherwise Dr. M. would have found the potash, I must not determine. Notwithstanding the sneering remark of his ounce or two of dropsical fluids being in competition with my "two or three pounds of "*ropy sputum*," I should be very unreasonable if I were not, after this practical proof of the inadequacy of Dr. M.'s method, to be well contented. If however, instead of treading the primrose path of the new microscopic school, he had condescended and submitted to the task of labouring in "the dismal, large, subterraneous laboratory;" if, I say, he had been there employed, instead of in dalliance at "*the fire-side of his comfortable study*," it did not require his talents to have done much more than nearly confirm the results of my experiments on animal substances. If too I can see the future in the instant, it will be only by experiments on very large quantities of the animal fluids that discoveries can be effected of more of their impregnating ingredients; on account of the very minute proportions in which they exist.

Dr. Marcet thinks it worth while to disclaim his memoir as the joint work of Dr. Wollaston and himself. I cannot have the smallest objection: indeed, by this I gain strength on my side; for the demand of justice alone compelled me to consider this writing as I have done. I must, however, be allowed to cite a single passage in justification. Besides the advantages from Dr. Wollaston's writings and conversations, Dr. Marcet owns "*his kind personal assistance in this and other similar inquiries.*"

I am accused of the unwarrantable license of "quoting in

in italics, and placing between inverted commas, words which have not been used by my adverse friend—such base proceedings I am charged withal! As for italics, I knew no better than that all writers, for the sake of emphasis, do employ them either for their own words or those of other writers. The word *elegant* so complained of is not intended as a quotation, it is my own word which Dr. Marcet has mistaken. As for inverted commas, the very few passages they include, I think no one would apprehend are his writing, except two or three instances. Here I cannot perceive any misquotation worth the slightest notice, being of perhaps of a word or two only, except one passage. There I confess the heinous offence, and express my contrition sincerely, viz. for "fire-side of the *drawing-room*," in future read "the large dismal subterraneous laboratory is now changed for the fire-side of *a comfortable study*."

Again: my respectable adversary is offended with what he is pleased to call *irony*. I can do no more than declare, whether I shall be again accused of irony or not, that I entertained more of respect than sufficient for subduing any such humour.

The last offence is *jocularity* not suitable for the advancement of science. If in such a vein I have written offendingly, "I have shot mine arrow o'er the house and hurt a brother." This mode of writing, however, has the high authority of a great poet and still greater philosopher:

> "——— ridentem dicere verum
> Quid vetat?"

I wish I could be more frequently jocular, as so many occurences in common life are experienced to make one sad. Hence, I would rather live with Horace, than with the melancholy moralist Jaquez. Some allowance, too, should be made for the differing natures of individuals, from the elements being so differently mixed:

> "Nature has made strange fellows in her time:
> Some there be of such vinegar aspect,
> That they'll not show their teeth in way of smile,
> Though Nestor swear the jest be laughable."

The foregoing pages of rejoinder will, I trust, save me the trouble of many intended remarks on Dr. Marcet's paper, independently of its relation to the questions at issue. A few comments only I now beg to be allowed to deliver.

1. *The animal matters* in the fluids examined are stated to be of two kinds, viz. *coagulable* or *albuminous matter*, and

and what the author calls *muco-extractive*. I do not at all object to the experiments, but appeal to competent judges whether it is not unjust to make this distinction. The evidence of the *coagulable* matter is from the visible coagulation by calorific and some re-agents; but if there be not a due proportion of it to the water in which it is dissolved, such evidence is not obtainable. This may be easily proved, and, as I apprehend, I have shown in my published papers, by a kind of synthetic experiment. For example: serum of blood, or any other known coagulable fluid, may be so diluted with water as to afford no distinct proof of its presence by coagulation on applying calorific, although such an effect may be reasonably inferred, on probable grounds, from the disturbance of transparency or cloudiness. And as far as I have found by experiment, coagulable matter so diffused, on being collected by evaporation to dryness, is scarcely coagulable by calorific; so that the whole of any given quantity of animal coagulable fluid by such treatment was rendered uncoagulable. According to my trials, too, there always remained, on coagulating serum and other analogous fluids, a small proportion of animal matter dissolved in the watery part, which differed in no respect from the matter left on evaporating water, containing a certain small or uncoagulable proportion of serum added to the water, as above stated. But these dilute solutions, which appear uncoagulable, denote the presence of animal matter to the test of tannin. It was probably this property, and the animal matter afforded by evaporation, which induced some chemists to conclude that a different kind of animal substance from coagulable, such as gelatinable, existed in the serum of blood. Hence I conclude, that the two grains of what Dr. Marcet calls *muco-extractive* matter, afforded by 500 grains of serum after separating 44 grains of albumen or coagulable matter, is this matter rendered uncoagulable by dissolution. And hence too, I conclude, that the animal matter in the other animal fluids which he examined, was of one kind only, viz. *coagulable matter*, but not demonstrable by its distinguishing property on account of dissolution in a large proportion of water.

2. *Ammonia* is not mentioned among the impregnating ingredients. This is to me not surprising, for it is evidently from my experiment in so small a quantity as to be undiscoverable in the proportions employed. If I could not find by estimation above half a grain weight of it in seven or eight thousand grains of animal matter, it was not likely to be rendered evident in seven or eight hundred grains.

3. *Sul-*

3. *Sulphate of potash.* That a *sulphate* exists I perceived in my experiments, and have accordingly inserted it among the saline matters in my published papers; but that it is sulphate of potash I apprehend will not be allowed to have been shown by Dr. Marcet.

4. *Phosphate of lime, of iron, and of magnesia,* are enumerated in the memoir before me. Of phosphate of lime there is good evidence, as I have set forth, and coincide in my results with those of the author, as well as that there is probably phosphate of magnesia; also that there is iron: but I was not able to infer that it was in the state of phosphate, I only inserted it in my results as an oxide. Although it is not essentially connected, it may be useful to refer to a process which I offer as evidence against the common opinion that the red and black colour of the blood is owing to iron. I have mentioned it in my lectures during some past years. The result is published in the Edinburgh Medical and Surgical Journal, vol. vii. p. 124, for January 1811. I collected 110 grains of the red part of blood in a dried state, by repeated ablutions from 10,000 grains or upwards of twenty ounces of blood. By burning in a platina crucible it afforded, in weight, two grains and a half of a half-fused brown tasteless substance. By boiling in muriatic acid a part was dissolved. This solution was not styptic to the taste; it became blackish on adding tincture of gall nut, and on adding prussiate of potash it afforded a deep blue coloured precipitate, which did not yield on ignition above half a grain of reddish brown powder. Is it then probable that twenty ounces of blood should derive its colour from half a grain of oxide of iron? I think proper to speak of this result, at this time, because it was published anonymously, and because subsequently to its publication I find it has been mentioned by other persons without acknowledgement; perhaps from not knowing this circumstance.

5. I found also indications of *carbonate of lime* and of *silica* not enumerated by Dr. Marcet. Future experiments must however furnish unequivocal evidence.

6. *Muriate of potash* inserted by the author instead of *potash united to animal matter*, or to some other destructible substance as I have inferred. On this question perhaps more than necessary has been already said in the present and former papers.

7. *Subcarbonate of soda* asserted by the author has been the subject of discussion at the same time as the last-mentioned ingredient.

8. *Muriate of soda.* Both parties agree in this being the chief saline impregnation.

It may be right to notice that I have employed the term *self-coagulable lymph* instead of the usual one *coagulable lymph*; because the serum, another fluid of the blood, is also coagulable; not indeed of itself, but at a certain temperature, or on the admixture with certain substances. The deposit spoken of by Dr. Marcet is not, I think, as he supposes, what I mean by the term self-coagulable lymph.

Although, if the cause of truth require it, another communication may be offered, it will be most agreeable to me, that it be not found necessary. Considering the erroneous inferences with which the writings of chemistry abound by men of the greatest celebrity, I shall on that account find a source of consolation if time show that I am the erring party. I hope too that this controversial discussion may serve to promulgate knowledge, by inducing some persons to attend to the subject who might not otherwise have known the original papers. If with these reflections my respectable adversary can be satisfied, the controversy will now be terminated:

"Claudite jam rivos, pueri: sat prata biberunt."

G. P.

George-street, Hanover-square, April 17, 1812.

XLIII. *Case of Hernia Umbilicalis, operated on with Success during Utero-gestation.* By JOHN TAUNTON, *Esq. Surgeon to the City and Finsbury Dispensaries, and to the City Truss Society, Lecturer on Anatomy, Surgery, Physiology, &c.*

June 29, 1811. MRS. E. P. aged 42, three months gone with child, has had an umbilical hernia for 20 years, as large as a full-sized teacup, but never found any inconvenience from it till yesterday, when, as she was walking in the street, a boy ran against her, and struck her upon the tumour, which occasioned much pain. A neighbouring surgeon and apothecary, who attended the family, was requested to see her. She had sickness, vomiting, hiccough, and constipation of the bowels; the pain, attended with a sensation of heat, was principally referred to the region of the stomach. Aperients, opiates, and enemas were given: the former were rejected by the stomach, and the latter produced no effect on the bowels: fomentations were applied to the abdomen without relief. These means were pursued

pursued without benefit, and the symptoms increased till the morning of the 2d of July, when I was requested to see her.

The operation was immediately recommended, and acceded to on her part. Indeed, I considered that too much delay had already taken place.

The integuments over the hernia were very thin, and in close contact with the peritoneal sac, which was also very thin, and every where in contact with and adhering firmly to the omentum. The omentum was partly torn through, and partly dissected from the peritoneal sac, and a considerable portion of it was removed before the convolution of intestine was brought into view. The omentum was much inflamed, and in places approaching to a dark green colour. The convolution of intestine was very dark, nearly in a state of gangrene. The stricture was very deep and firm; but when dilated there was not any impediment to the return of the bowel: nearly the whole of the omentum contained in the sac was removed. The extent of the inflammation on the omentum and intestine, the latter appearing almost in a state of gangrene, induced me to observe to the gentlemen who had been attending the case, that I was fearful that too much time had been lost, and that it was of the utmost importance to the safety of the patient, that the operation for hernia should be always performed early.

July 3d. She had a natural stool, was free from fever, and continued to recover without any unfavourable symptoms. The wound was completely healed in a month, and she was as well as usual, and continued so till her labour came on at the usual time. The hernia then protruded and became strangulated: she had sickness, hiccough, vomiting, and constipation. She continued in this state for two days, when she was safely delivered. The hernia was still irreducible, and the vomiting and constipation continued till the next day, when the tumour lessened and the symptoms were relieved. At times she has had violent pains in the part, and the tumour has become tense and irreducible for a short period; but these symptoms have generally subsided without any surgical assistance. She could never be prevailed upon to wear a proper truss, though strongly recommended so to do.

April 20, 1812, 4 P. M. I was requested by her husband to visit her on account of her old complaint, of which she was now very ill. From his representation of the case I took my instruments, and Mr. Burn to assist at the operation should it be found necessary, in order that no time

should be lost. We called upon the medical gentleman who had the care of the patient in this as well as in her former illness, to learn the history of the case now, and to have his assistance; but he was from home, having left a message that I was to do what I pleased with her. On his assistant referring to his day-book, it appeared that she was taken ill with symptoms of strangulation on the 16th, and visited by this gentleman on the 17th, when the symptoms were very urgent, and the hernia irreducible.

℞ Magn. sulphas ℥ ß.
Mist. amygdal. ℥ vi. M. Fiat mist. Cochl. iij. 4tis horis.

On the 18th the symptoms had not been at all relieved, and she was worse in every respect. The following mixture, which she has been in the habit of taking subsequent to the former operation, was sent.

℞ Magn. sulphas ℥i.
Mannæ ℥i ß.
Aq. menthæ ℥vij. M. Cochl. iij. 4tis horis.

A common glyster with one ounce of salts was now administered without any good effect.

On the 19th all the bad symptoms were aggravated: another glyster of the same kind was administered, and some castor oil which she had in the house was taken. She appeared at this time much worse; the castor oil was taken in coffee in the evening, and remained on the stomach during the night.

On this morning (4 A. M. 20th) the skin on the lips, hands and feet, and on the hips and loins, was discoloured, rather purple: another glyster was administered, and three pills composed of jalapi ℈i. Hydr. submurias grs. x. were taken, and immediately rejected by the stomach. Stercus matter was now vomited, and all the symptoms indicated the greatest danger. Yet it does not appear that any means were taken to endeavour to obtain relief till 4 P. M. when I was first applied to, and visited her immediately*.

The pulse was low, weak, and irregular, at times the beat scarcely perceptible; cold clammy perspirations partially diffused over the body; the extremities cold and of a very dark colour: the skin on the face was nearly purple, and on the lips almost black; her strength was so much reduced

* The above particulars were obtained from her husband, children, and herself, and also corroborated by the testimony of the assistant to the gentleman who had attended the case.

that

that she was not able to turn herself or to raise herself in bed without assistance.

The tumour was rather of a livid colour, not very tense, but had that peculiar feel as if it was filled with fæces from a rupture of the intestine. There was but little pain in the hernial tumour, or on the lower part of the abdomen; but above, and rather inclined to the left side, there was a small part more tense and painful on pressure.

After stating the extreme danger in which she was, both to herself and to her husband, I named the operation as the only thing to be done, which could give any chance for her life, and left it for them to decide; which they did in the affirmative.

The incision was made in the direction of the linea alba, through the integuments, which were very thin and adhered in every part to the peritoneal sac. There were about 3 oz. of a straw-coloured fluid contained in the sac. The intestine was now exposed, being of a dark colour, almost black. The peritoneal coat was abraded or ulcerated on one part, to the extent of the size of a shilling: the stricture was between three and four inches deep, requiring the whole length of the bistoury: it was dilated a little both above and below, in the direction of the linea alba: there was no adhesion or impediment to the return of the intestine, nor was any force required. When the stricture was dilated, it appeared almost to withdraw itself into the abdomen.

The edges of the wound were laid together, and supported by strips of adhesive plaster and a compress of lint; the whole confined by a common roller.

The following medicine was ordered, and two table spoonfuls directed to be taken every second hour.

℞ Conf. arom. ʒii.
Spt. lavd. comp. ℥ifs.
Tinct. opii ʒi.
Aq. menth. pip. ℥vifs. M.

On visiting her at nine p. m. four hours after the operation, the sickness and vomiting had entirely subsided. She had taken three cups of tea, which she seemed to like. She was still very cold, the clammy perspirations were not abated, and the skin was almost as much discoloured as it was before the operation: but on the whole she felt herself relieved. The medicine was directed to be continued. She died at four o'clock in the morning, eleven hours after the operation.

It has often fallen to my lot to record similar cases to the

the above, in the pages of your valuable Journal; and it is with no small regret that I do relate such cases, and that I see no prospect of the number of these cases being diminished, not even in London. Although here the physician can *without delay* have the advice of his colleagues, the surgeon the *immediate* assistance of his professional brethren, and the apothecary may have the advice and assistance of both physician and surgeon *almost instantly*; yet that wilful perverse desire of pursuing a routine of unsuccessful practice, of keeping the patient from proper assistance, for the purpose of making merchandise of his maladies, by the sale of a few medicines, still prevails and is equally disgraceful to the profession, as it is almost certainly fatal to the patient. In the instance before us, a valuable parent was snatched from a *numerous offspring*, surely hurried to an untimely grave by a want of that assistance *which had been successful in a former case*, and which would in all human probability have been again completely successful, had it been applied in proper time.

The operation for hernia is simple, and, when performed with care, in proper time, is almost certainly successful. "Few, if any, would be the fatal cases of this operation, if it was performed sufficiently early*." The result of many years practice, in which the number of operations on persons afflicted with this malady has been very considerable, enables me to speak with well grounded confidence on the success of this operation.

21, Greville-street, Hatton Garden, April 23, 1812. JOHN TAUNTON.

XLIV. *Notice respecting the Geological Structure of the Vicinity of Dublin; with an Account of some rare Minerals found in Ireland. By* WILLIAM FITTON, *M. D. Communicated by* L. HORNER, *Esq. Secretary to the Geological Society*†.

THE following observations are to be ascribed principally to the late Rev. Walter Stephens. I communicate them to the Geological Society in their present imperfect form, with the hope that they may attract the attention of mineralogists to the country in the vicinity of Dublin; for they are sufficient to show that very interesting information may be expected from a correct examination of that district, the

* Hey's Surgical Observations.

† From the Transactions of the Geological Society, vol. i. with some additions by the Author.

situation

situation of which renders it easy of access, and affords many advantages to the observer. I shall subjoin to a brief statement respecting the geological structure of that country, an account of some minerals of not very common occurence recently found in Ireland.

The city of *Dublin* is placed in a flat country, at the distance of about three miles from the sea, and about five miles to the north of a range of mountains forming the verge of an elevated district which extends from thence for more than thirty miles to the south. This district is bounded on the inland or western side by a continuation of the plain of the neighbourhood of Dublin; and its breadth from the sea, which forms its boundary to the east, is generally about four-and-twenty English miles.

The basis of all the plain to the north and west of the mountains above mentioned, appears to be secondary (flœtz) limestone.

The mountainous district itself is principally composed of primitive rocks: it is traversed through its whole extent by a broad tract of granite, which, taking its rise on the shore at the south side of Dublin bay, crosses the county of Wicklow in a south-western direction; being bounded by incumbent rocks of great variety, the structure and relations of which, as well as of the granitic mass, are in several places very distinctly exhibited.

The relative extent of the space occupied by the granite, and by the rocks that occur between it and the calcareous country, and the general position of their boundaries, may be understood from the annexed sketch*; in which it is to be remarked, that the places where the boundary is denoted by a dotted line remain still to be explored, the line having been there inserted only for the purpose of illustration.

The granite has been observed in contact with other rocks at the following places in the counties of Dublin and Wicklow: viz. on its eastern boundary,—at *Killiney;* at the southern extremity of the *Scalp*; in the bed of the second streamlet which joins that of the *Powerscourt Waterfall*, above the fall; from the neighbourhood of *Luggelaw* to the head of *Loch Dan*, and from thence to the upper part of *Glenmacanass;* at *Tonelagee;* at *Aghavanagh* in the course of the military road about a mile to the east of the barrack; and at the western branch of the Coolbawn stream on the north-west flank of the mountain *Croghan Kinshela*†. The

* The sketches referred to in this paper will be given with our next Number—Plate VII.—Editor.

† Report on the Gold mine by Messrs. Mills and Weaver. Transactions of the Dublin Society, vol. iii.

boundary

boundary of the granite on its northern and western confines is much less regular than on the east; it probably commences on the shore of Dublin bay between *Booterstown* and *Blackrock,* a mass of limestone having been observed there within a short distance of granite, but the rocks are concealed in the intervening space. The granite comes nearly into contact with limestone again, near the junction of the stream from *Dundrum* with the river Dodder a little above the village of *Milltown;* and is visible near schistose beds in the course of the streamlet between *Whitechurch* and *Rathfarnham.* It has been observed in contact with schist to the west of the Glen near the head of the *Dodder,* nearly opposite to a little village called the *Brakes* of *Glassnamucky*, but from that place to the west and south, the line of boundary has been very little explored: it passes however very near the granite quarries at *Golden-hill,* and must run to the east of *Poula Phuca* and the Glen of *Holywood.* A junction occurs at Ballyroan on the south-western side of *Kilranelagh-hill;* and granite has been observed in that neighbourhood, to the east of Kilranelagh at Knockaderry, and to the south of it at Killalish, Kiltegan, Kilmacart, and near the town of *Carlow* where the limestone appears, at Brownshill.

The slaty rocks incumbent on the granite in this country are very much diversified in their nature, and they have hitherto been very little examined. On its eastern confines, in the places above-mentioned, the prevailing rock is mica slate, the beds of which in general lean towards the granite, their direction being nearly parallel to the line of junction: rocks of the trap kind occur to the west in the neighbourhood of Ballinascorney, and at Kilranelagh; and columnar rocks of the same description have been observed at Arklow-rock on the south-eastern extremity of the county of Wicklow.

The country around the village of *Bray,* which, like that of Wicklow in general, is remarkable for the picturesque beauty of its scenery, presents within a small space several very interesting geological appearances; and those observable at Killiney, first noticed I believe by Dr. Blake of Dublin, will be found particularly deserving of examination: the line of junction, which, as already mentioned, has been traced for several miles across the country, commencing on the shore at the base of *Killiney-hill,* where schistose beds are to be seen to a considerable extent, reposing upon granite.

On the shore from thence to *Dalkey,* the granite is traversed

versed by numerous veins, many of which are themselves composed of granite; and in several instances two such veins, differing from each other and from the mass through which they run, in fineness of grain, and in the proportion of their ingredients, are seen to intersect, one not unfrequently deranging the continuity of the other's direction*. The substance of which these veins consist is perfectly continuous with that of the rock in which they occur, and the surface of fracture passes through both without interruption.

The regularity of the line by which the granite is bounded at *Rochestown-hill* is highly deserving of attention. "From the top of the hill a very remarkable ledge of granite runs in a straight line, for upwards of a quarter of a mile, extending from a little below the summit on its south-eastern side in a direction from N.N.E. to S.S.W. This ledge, which is elevated a few feet above the ground to the south-east of it, appears to form the boundary of the granite. The schist in this place seems to run up in a wedge-like form between this ledge and another a little to the eastward, which is much less extensive than the former but corresponds pretty nearly with it in direction, its course being from S.W. by S. to N.E by N.; and beyond this again still further to the east, another wedge-like branch of the schist runs up between this second ledge and the obelisk hill."

"In the annexed sketch A denotes the summit of Rochestown hill; B, the first ledge of granite; C, the second ledge; D, the third ledge; E, part of the obelisk hill†."

The whole of the *Greater Sugar-Loaf* mountain is composed of quartz; and the adjoining hill of *Stile-bawn* and the rocks at the upper part of the *Dargle* consist of the same substance; which also constitutes the mass of the *Lesser Sugar Loaf* mountain, and the summits of *Shank-hill* and of *Bray-head*, resembling it in figure and in general aspect‡. It appears therefore that all the summits of this vicinity which agree in form, are composed of the same material; and it is remarkable that the conical shape characterizes mountains consisting of quartz in various parts

* The mode of intersection of these veins is illustrated by the annexed Sketch, figs. 1, 2, 3, 4, and 5, representing detached portions of veins observable in different places along the shore at Killiney; figs. 7 and 8 are from large loose blocks on the strand there: these, however, were not the most remarkable that might have been selected.

† Extracted from a note by Mr. Stephens.

‡ See the annexed Sketch.

of

of the globe*. I am informed by Mr. Jameson that he has seen in Lusatia detached conical summits composed of that substance; and that the summits of the same figure in the mountains separating Caithness from Sutherland are likewise formed of it; as are also the *Paps* of Jura in the Western Isles†; and according to Dr. Berger, the mountain *Durnhill* near the town of Portsoy in Scotland.

The principal mines which have hitherto been opened within the mountainous district near Dublin, are those of copper ore at *Cronebane* and *Ballymurtagh*, the metalliferous waters of which were described in the Philosophical Transactions so long ago as in the year 1757‡; and of lead at *Glenmalur* §, at *Glendalogh*, at *Dalkey*, and at *Ballycorus* near the Scalp. The stream works commonly called "the Gold-mine" were situate on the north-east side of the mountain *Croghan-Kinshela* on the southern verge of the county of Wicklow; and gold has been found within that county at another mountain named *Croghan-Moira*, about eight English miles to the north of that place||.

The occurrence of *Tinstone* at the "Gold-mine, where it has been obtained in fragments¶, is a fact which deserves particular attention; for the probability of the discovery of veins of that valuable ore within a tract of primitive country so extensive as that of Dublin and Wicklow, appears from this circumstance to be considerable.

Porcelain-earth resulting from the decomposition of felspar, has been found at Kilranelagh in the county of Wicklow, in purity nearly equal to the Cornish "China clay:" and granite is found in a decomposed state so commonly in other parts of that county, that this valuable production may with much probability be expected to occur there in other places, and in considerable quantity.

* Siliceous earth in the form of this mineral, and consequently nearly pure, seems to constitute a much greater portion of the earth's surface than some mineralogists have supposed. Humboldt states that near Caxamarca in Peru, a mass of more than nine thousand feet in thickness is exclusively composed of quartz:—he has not mentioned the form of the summits. *Tableau Physique*, p. 128.

† See Walker's Œconomical History of the Hebrides, vol. ii. p. 392.

‡ Vols. xlvii. and xlviii.

§ The sales of lead, from ore raised and smelted at the Glenmalur mine, amounted during the year ending December 31st, 1811, to no less than 9819*l.* 16*s.* 2*d.* Irish currency: the weight of metal sold was 6680 cwts. 2 qrs.

|| Gold is said to have been found also at the *King's* river, near the village of Holywood, in the county of Wicklow.

¶ Report on the Gold-mine by Messrs. Mills and Weaver. Trans. of Dublin Society, vol. iii.

The

The flat calcareous country of the neighbourhood of Dublin is very widely extended in various directions: it passes round the mountainous tract above mentioned at its north-western angle, and reaches with little interruption, in a southern direction, through the counties of Kildare and Carlow, to the foot of the hills of the Kilkenny-coal-district; and to the south-west, through the King's and Queen's counties, to the foot of the Sliebh-bloom mountains. It has also considerable extent towards the north and west.

In the parts of this plain more immediately in the neighbourhood of the city, the prevailing rock is that variety of limestone to which Mr. Kirwan has given the name of *Calp*, of which an excellent description and analysis have been published by the Hon. Mr. Knox*: But in several parts of the flat country, limestone of the ordinary kind abounding in petrifactions is also to be met with.

In the course of the river Dodder, between the village of *Milltown* and *Classon's Bridge*, the calp appears to alternate with beds of granular *magnesian-limestone* in its characters perfectly resembling some of the substances that occur in various parts of England, which are described as affording a lime injurious to vegetation, in Mr. Tennant's very important paper "on different sorts of lime used in agriculture†." The magnesian stone at Milltown agrees with the calp and ordinary limestone of the adjoining country in containing petrifactions, although less commonly; and like them also it has frequently imbedded in it masses of siliceous matter, (the "Lydian stone," or a variety of hornstone of Werner.)

The beds of calp and limestone near Dublin, are in general but little inclined to the horizon; but they often exhibit marks of dislocation; and in some places are singularly inflected, as is remarkably the case with those observable in the bank of the river Liffey, near the bridge at *Lucan*.

The petrifactions which abound in several parts of this calcareous country ‡; the beds of calp, and of magnesian limestone, and the siliceous masses above mentioned, afford some of the features that may assist in deciding to which of the "formations" of Werner it is to be referred, or whether it properly belong to any of them: a point of

* Trans. of Royal Irish Academy, vol. viii. p. 207.

† Philosophical Transactions 1799, or Philosophical Magazine, vol. v. page 209.

‡ The quarries at *St. Doolagh's*, and in the neighbourhood of *Feltrim*, afford very perfect specimens of petrifactions, and in great variety.

some

some interest in a geological view, from the great extent of the space occupied by limestone in several of the counties near Dublin.

At the peninsula of *Howth*, which forms the southern side of Dublin Bay, grey ore of manganese, and brown iron stone (Museum of Dublin College, Nos. 1067-8. 887.) have been obtained in considerable quantity: and a variety of the earthy-black-cobalt-ore of Werner has been found by Mr. Stephens and Dr. Stokes at the south west side of the hill, in the form of a coating of a rich blue colour, which incrusts the fissures of a rock of slate clay, nearly approaching to whetslate (Museum of Dublin College, No. 267): Mr. Tennant has in this substance ascertained the presence of the oxides of cobalt and of manganese; and the discovery of it is important, as it indicates the probability of the existence of other more valuable ores of cobalt in that neighbourhood.

The heights of very few of the mountains near Dublin have hitherto been measured: the only published observation with which I am acquainted, being that given in a section annexed to the report on the Gold-mine by Messrs. Mills and Weaver already referred to; where the summit of the mountain *Croghan Kinshela* is stated to be 2012 feet above the river at Kilcarragh bridge, which is about four miles from the sea. I have myself ascertained by the barometer the heights of the following places in the county of Wicklow, above the house of Mr. Greene, at Kilranelagh, viz.—

	Feet.
Lugnaquilla, supposed to be the highest mountain of the county	2455·1
Cadeen, a mountain detached from the rest, and a conspicuous object from the adjacent flat country	1558·9
Baltinglass-hill	681·8
Eadestown-hill	749·4
Brusselstown-hill	740·1
Kilranelagh-hill	705·5*

* The first three heights above mentioned, are each the mean of three observations, the rest are from single observations with two excellent barometers. Mr. Greene's house is (by a single observation) 95,08 feet above the level of the cross roads at the bridge of *Tuckmill*, a little village on the river Slaney, the elevation of which above the sea will be very well supplied, when a branch of the Grand-canal shall be extended in this direction, as is now intended. The distance of Tuckmill from the sea in a direct line is about eighteen English miles.

Of

Of the mountains nearest to Dublin :

	Feet.
Garrycastle, one of the highest, is	1531·7
Three-Rock mountain, adjoining the last	1247·9

above the level of the road at Ballinteer, near the house of Dr. Stokes, the height of which above the sea is considerable.

The highest point of *Howth* is .... 567 feet above high water mark.

The elevation of the plain country of *Kildare*, may be judged of from that of the summit level of the Grand-canal, by which it is crossed to the north of the hill of Allen: that level being 264 feet above high water in Dublin Bay, taken from a mark made at the Pigeon-house by order of the Ballast-Office.

[To be continued.]

XLV. *Proceedings of Learned Societies.*

ROYAL SOCIETY.

April 9th and 16th. A PAPER was read on arsenic, by Dr. Lambe of King's Road, Bedford Row, communicated by the late Dr. Garthshore.

The principal object of Dr. L.'s labours on arsenic seems to have been to defend an hypothesis proposed by him, a considerable time ago, in two successive publications, namely: "An Inquiry into the Origin of Constitutional Diseases," and "Reports on Cancer," in which the Doctor attempted to show the analogy between the action of putrid matter and arsenical poison. The facts of most consequence in the paper read as above to the Royal Society, are the following:

1. One part of charcoal was mixed with ten of white arsenic and twenty of nitre: after deflagration, no signs of carbonic acid could be detected, as would have happened had no arsenic been present.

2. Small quantities of charcoal mixed with white oxide of arsenic had the same effect as upon many other metallic oxides, producing carbonic acid and carbonic oxide.

3. In the reduction of arsenic by mixing white arsenic, half its weight of subcarbonate of soda, and $\frac{1}{6}$th part of charcoal, there appeared a peculiar gas in the early stage of the process. It could not be inflamed by a candle, (mixed either

either with oxygen or common air,) but was inflammable by electricity, and was thus convertible into carbonic acid, and a considerable portion of azote remained after the inflammation. The properties of this gas changed by being kept in a phial uncorked: the inflammable portion diminished, and the residuum of azote increased.

After this gas had come over, large portions of hydrogen and carburetted hydrogen were obtained. They were mixed with small portions of azote and oxygen to the end of the process.

Besides these gases there was also carbonic acid in great abundance.

4. These experiments were performed in earthen retorts, which might be suspected to permit some atmospheric air to pass through their pores: and such appears on trial to be the case. For, on using glass retorts, the results were considerably different. The first products were carbonic acid, and small quantities both of azote and oxygen, which were left after the carbonic acid had been removed by lime-water. But towards the end of the process, instead of a residuary portion of azote and oxygen, a peculiar gas was observed similar in many respects to that described. It could not be inflamed by a candle, when mixed with atmospheric air, or with oxygen gas; but it inflamed by a smart electric shock, and carbonic acid was produced. A more minute research detected also the production of nitric acid from the detonation of this gas. On this account Dr. Lambe has given it the name of *nitro-carbonic oxide.*

5. When this process was conducted in glass retorts, not the smallest vestige of hydrogen or carburetted hydrogen could be observed, which were so abundant when the earthen retorts were used. But still small quantities both of azote and oxygen came over to the very end. Water also appeared to be produced in every stage of the process.

April 23. Part of a Marine Meteorological Journal, by Capt. Heywood, communicated by Capt. Horsburgh, was read.

SOCIETY OF ANTIQUARIES OF LONDON.

Thursday April 25, being St. George's day, the Society of Antiquaries met at their apartments in Somerset Place, in pursuance of their statutes and charter of incorporation, to

to elect a President, Council, and Officers of the Society for the year ensuing—whereupon

George Earl of Aberdeen, K.T.
Edward Astle, Esq.
F.A. Barnard, Esq.
William Bray, Esq.
Nicholas Carlisle, Esq.
Thomas Lord Dundas,
Sir H. C. Englefield, Bart.
Anthony Hamilton, D.D.
Charles Monro, Esq.
Craven Ord, Esq.
Matthew Raper, Esq.

Eleven of the Council, were re-chosen of the New Council; and

The Right Hon. Charles Abbot,
Heneage Earl of Aylesford,
The Right Hon. Sir J. Banks, Bart. K. B.
John Lord Brownlow,
Taylor Combe, Esq.
Henry Ellis, Esq.
George Lord Kenyon,
R. P. Knight, Esq.
Samuel Lysons, Esq.
John Lord Redesdale,

Ten of the other members of the Society, were chosen of the New Council, and they were severally declared to be the Council for the year ensuing; and, on a report made of the Officers of the Society, it appeared that

George Earl of Aberdeen was elected President.
William Bray, Esq. Treasurer.
Matthew Raper, Esq. Director.
Nicholas Carlisle, Esq. } Secretaries.
Rev. T. W. Wrighte, M. A. }

RUSSELL INSTITUTION.

In Mr. Bakewell's third lecture, he noticed the fractures and fissures in the earth's surface, which are filled with mineral substances differing in quality from the rocks or strata they intersect. In travelling over an extensive range in a mountainous country, he observed that the form and inclination of the hills may present the same general resemblance for a considerable distance; but we may sometimes perceive that in certain situations the same kind of rock is thrown into a different position, and the strata are inclined in an opposite direction. When such a change of position occurs, then we may be almost certain that a rent or fissure of the earth's surface has taken place, and that the continuity of the strata has been broken by some cause which has elevated one side and depressed the other. These rents are called by miners dykes or faults. In the northern part of our island, they are frequently filled with basalt or whinstone. In the coal districts of Yorkshire, and in the midland counties, they are more frequently filled with clay. In some situations, where these dykes occur in contact with coal, the coal

appears

appears charred on each side. He stated instances of this in the county of Durham, and in Shropshire. Such phænomena appear to indicate that the basalt had been ejected into the fissure in a state of igneous fusion.

The length to which dykes extend has in few instances been traced, owing to the upper part being hid by a covering of loose earth or soil. They vary in width, from 6 inches to 70 feet or more. Their depth remains unascertained. Veins of granitic and other rocks occur also amongst primary mountains.

Metallic veins resemble dykes in their structure, but not in their contents, being filled with different metallic substances in a state of ore, and intermixed with various crystals and earths. Mr. Bakewell described the contents of many remarkable veins in England and other parts of the world, and the extent and depth to which they have been traced. He explained their inclination, position, and structure, by various drawings and specimens. It appeared from his description, that the Eton copper mine has been worked to a greater depth than any other mine in England, ore having been lately got at the depth of 236 fathoms, or 472 yards. Mr. Bakewell described the various states in which the same metal is sometimes found in one mine, as native metal, or as alloyed with other metals, or mineralized by oxygen, sulphur, or acids.

The lecturer proceeded to observe, that the question "In "what manner have metallic veins been filled with their "contents?" has greatly divided the opinions of Geologists. Dr. Hutton supposed that mineral and metallic veins have been formed by the breaking of the solid rocks from the expansive force of subterranean fires, and their contents ejected into them in a state of fusion from below. Mr. Werner supposes they are fissures produced by the shrinking or drying of the materials of which rocks are composed, and afterwards filled from above by the metallic matter in a state of solution. Both these theories, Mr. Bakewell observed, were at variance with the appearances which mineral veins present.

The favourable reception which Mr. Werner's system of the formation of metallic veins has met with, was, he said, a striking instance of the extent to which an attachment to theory can be carried, and close the eyes of its votaries to the plainest and most obvious facts. Had metallic veins been filled from above, by the metallic ores infused in a state of solution, this solution must at one time have covered the whole earth, and the ores deposited by it would have filled all

all the valleys and cavities on the earth's surface, and would not have been confined to the narrow fissures or veins in which they are found. There are, however, he observed, existing facts equally decisive against the theories of Dr. Hutton and Mr. Werner respecting the formation of veins. It is almost universally found, that where a metallic vein passes through a mountain composed of beds or strata of different kinds of rock, the nature or quality of the ore varies in each kind of rock. This is the case in Cornwall: where the same vein traverses grau-wacke or kilias and granite, it is found to be more rich in the latter rock. In Derbyshire, the veins of galena which pass through the limestone rocks disappear in the basaltic amygdaloid by which the lime rocks are separated; or, if the vein passes through the amygdaloid, it very rarely contains any quantity of metallic ore. It is also found that different strata or layers in the same bed of lime rock are more productive in ore than others. If metallic veins were filled by infusion from above, or ejected from below, it is impossible that the nature of the rocks they traverse could alter the quality or quantity of their products. This fact, though undeniable, has never, Mr. B. observed, been properly attended to, and is alone decisive against the received opinions respecting the formation of metallic veins, and seems to prove that the rock itself has been in some manner operative in the production of their contents.

Mr. B. observed, that the present state of chemical science did not admit us to form any decisive or satisfactory opinion on this subject, and he considered it much wiser to acknowledge our ignorance, than frame theories which only serve to perpetuate error. It is not at present fully ascertained, whether metals be simple substances, or compounds: but this discovery, he said, must precede the formation of such a theory as will explain in a satisfactory manner many of the mysteries in the mineral kingdom.

Some experiments which he showed, offered, he said, hints to future discoveries on this subject. All the metals are capable of existing in peculiar solutions, and some of them (perhaps all) are also capable of becoming elastic invisible gases when united with hydrogen, and can be made to deposit the metallic contents in a solid form. In this manner they may have entered veins, and may have been separated from the substance of rocks, and decomposed by a process analogous to that of the Voltaic electricity, the different sides of the vein acting like the opposite ends of the pile.

Mr. Bakewell observed, that much yet remained to be done to improve the processes of metallurgy, and, what was of more importance, to provide for the health and safety of the persons who labour in mines and the reduction of ores. The immense annual sacrifice of lives in the mines of Peru is a melancholy instance of the baneful effects resulting from ignorance, tyranny, and avarice. In Mexico, according to late observation, the condition of the miners is much improved. Science, Mr. B. observed, had ever been found the friend of man; and when she shall dawn on those regions, her beneficent effects will soon be felt: she will teach him to supply subterranean works with salutary currents of air, and extend his researches with safety to far greater depths than have yet been explored. Scientific pursuits are not, as some may imagine, unprofitable speculations: they have always a tendency to enlarge the sphere of human power, to add to our comforts, and lessen the evils of suffering humanity.

GEOLOGICAL SOCIETY.

April 3.—Two new members were admitted. Two communications were announced, and the receipt of various presents of books and specimens was reported by the Secretary.

A notice relative to the geology of the coast of Labrador, by the Rev. Mr. Steinhauer, was read.

The only accounts that have been hitherto published concerning this part of the British dominions are the Memoir of Mr. (afterwards Sir Roger) Curtis, inserted in the Philosophical Transactions, and Mr. Cartwright's Journal.

The Moravian Missionaries in 1772 established in this country their first settlement, called Nain, in lat. 56° 38′; and subsequently Okkak in lat. 58° 43′; and Hopedale in lat. 55° 36′. In the course of the last year they doubled Cape Chudleigh in lat. 60° 20′, and descended on the western side of the same promontory as far as lat. 58° 36′.

The leisure of the Missionaries, when opportunities occur, is employed in collecting materials for a natural history of the country; they have kept tables of the thermometrical and barometrical variations, have procured specimens of most of the native vegetable productions, and have from time to time sent over specimens of such minerals as attracted their notice.

The general aspect of this dreary region is that of bare and barren rock towering in craggy eminences, and of sandy marshes,

marshes, on which are found a few pines and brushwood and aquatic mosses. In several parts of the country the rocks are intersected by chasms, running generally in a right line to a considerable distance, which when covered with snow form dangerous pitfalls. The highest mountains extend along the eastern coast: the elevation of one of them, called Mount Thoresby, has been ascertained by actual measurement to equal 2733 feet, and a few others probably attain the height of 3000 feet.

From the islands near Cape Chudleigh the Missionaries have sent specimens of large-grained pale granite with garnets. The island of Ammitok in lat. 59° 20′ consists entirely of a crumbling garnet rock, in which hornblende sometimes occurs. The mountains about Nachwak Bay furnish lapis ollaris.

On the south of the high land of Kiglapyed in lat. 57° the district commences where the Labrador felspar is found: this mineral occurs not only in rolled stones on the shore, but in spots in the rocks in the neighbourhood of Nain, and particularly in the rocks bordering a lagoon about 60 miles inland, in which Nain North river terminates. The same district also produces the hyperstene or Labrador hornblende.

At Hopedale a limestone occurs from which have been procured specimens of reddish limestone, of calcareous spar, and of a variety of schiefer spar.

The country to the west of Cape Chudleigh, as far as it has been explored, is called the Ungava; and abounds with red jasper, with hæmatites, and with iron pyrites.

April 17.—Two communications were announced, and the receipt of various books and specimens was reported by the Secretary.

An account of the brine springs at Droitwich, by Leonard Horner, Esq. Sec. Geol. Soc. was read.

The town of Droitwich has been noted for the manufacture of salt during at least a thousand years; but no detailed account has hitherto been published of the natural and chemical history of the brine springs from which it is procured. The brine springs are in the centre of the town, being situated in a narrow valley through which the small river Salwarp flows. The prevailing rock about Droitwich is a fine-grained calcareo-argillaceous sandstone of a brownish red colour, with occasional spots and patches of a greenish blue. At Doder Hill in the immediate vicinity of the salt pits the rock appears to be a stratified sandstone of a greenish gray colour, and more indurated than the red

X 3 rock,

rock. It also differs from this last in containing slender veins of gypsum.

No new brine pits have been sunk for the last thirty years: the only particulars therefore concerning the strata covering the salt, which Mr. Horner has been able to obtain, are derived from Dr. Nash's History of Worcestershire, and from an inhabitant of Droitwich who was on the spot when the last pit was sunk. From these authorities it appears that the depth of from 35 to 45 feet below the surface is occupied by beds of gravel, of red marly clay, and of blue and white stone. To these succeeds a bed of gypsum about 105 feet in thickness, immediately below which is what is called the *River of Salt;* which is a stratum of nearly saturated brine 22 inches in depth, lying on a bed of rock salt, the thickness of which is unknown, no borings have been sunk in it to a greater depth than five or six feet. In constructing the pits, the method is to sink a shaft about eight feet square into the gypsum, and then to pierce this bed by a borer four inches in diameter: the borer is known to have passed through the gypsum by its suddenly dropping 22 inches, the depth of the River of Salt. As soon as the borer is withdrawn, the brine suddenly rushes up and overflows at the mouth of the pit.

There are only four pits at present in use, and the annual quantity of salt which they afford is about 16,000 tons.

The brine from all the pits is perfectly limpid, and when in a large body has a pale greenish hue similar to that of sea-water. To the taste it is intensely saline, but without any degree of bitterness. The specific gravity differs in the different pits, probably on account of the greater or less accuracy with which the land springs are stopped out: that of perfectly saturated brine is equal to 1210·39 (water being 1000); that of the five pits examined by Mr. Horner was found to vary from 1206·11 to 1174·71; and an evaporation afforded from 2289·75 grs. to 1922·97 grs. of entire salt, dried at 180° Fahr., in a pint.

This salt, from a careful analysis, appears to be composed of

96·48 muriate of soda.
1·63 sulphate of lime.
1·82 sulphate of soda.
0·07 muriate of magnesia.

100·00

On comparing the brine of Droitwich with that of Cheshire, as described by Mr. Holland in his Agricultural Survey

vey of that county, and by Dr. Henry, in his paper on the subject in the Philosophical Transactions, it appears that the strength of the different brines is nearly the same; that the Cheshire brine contains rather a larger proportion of muriate of soda; that the Droitwich brine is free from carbonate of lime, oxide of iron, and muriate of lime, all of which are found in the Cheshire brine; and finally, that the latter is free from the sulphate of soda which is contained in the former.

WERNERIAN NATURAL HISTORY SOCIETY.

At the meeting of this Society on the 7th of March, the Secretary read an "Essay on Sponges, with descriptions of all the species that have been discovered on the coast of Great Britain," by George Montagu, Esq. of Devonshire. From Mr. Montagu's researches as to the constitution of sponges, it appears that no polypi or vermes of any kind are to be discerned in their cells or pores: they are, however, decidedly of an animal nature; but they possess vitality without perceptible action or motion. Mr. Montagu has divided the genus Spongia into five families, viz. branched, digitated, tubular, compact, and orbicular. Only fourteen species were previously known to be British. Mr. Montagu in this communication described no fewer than thirty-nine. A considerable number of the species are quite new, or have now for the first time been distinguished and formed by that indefatigable naturalist.

At the same meeting Dr. Yule read a memoir on the natural method in botany, in which he defended the existence of the series of natural affinity in plants against objections of Professor Willdenow and Dr. Smith, founded on the want of regularity in the series, &c. He contended, that the illustrious author of the artificial system never intended that it should supersede, but, on the contrary, that it should lay the foundation of, the natural classes, "quas plana genera nondum detecta revelabunt:" and that with this view he uniformly inculcated the study of natural genera, in conformity with his great maxim, "Omne genus naturale."

THE KIRWANIAN SOCIETY OF DUBLIN.

A new Philosophical Society has been established in Dublin, on a plan somewhat different from those already existing in that city. Its object is, to promote the cultivation of chemistry, mineralogy, and other branches of natural history; and it means to concentrate its attention to these pursuits exclusively.

The members, desirous of paying the greatest and only tribute of respect in their power to the venerable and illustrious Mr. Kirwan, long distinguished in the first rank of philosophers, for a long continued course of labours equally useful to the world and creditable to himself, have resolved upon establishing themselves under the name of the KIRWANIAN SOCIETY.

The Society, except during the summer vacation, holds its stated meetings once every fortnight.

Communications on subjects connected with the above sciences will be received and read to a meeting of the Society: for this purpose, a meeting will be even summoned at any time during the summer vacation. The more effectually to ensure the right of anteriority to any original communication, the day of its receipt will be registered in a book kept for that purpose.

In order that immediate publicity may be given to such communications, with the author's permission, an abstract is to be sent to the Editor of the Philosophical Magazine for publication in his succeeding number. Further, the communication itself, if deemed of sufficient merit, is to be published at full length in the Transactions which the Society intends to conduct.

The Society will gratuitously circulate concise printed directions, for the selection of such important or rare minerals as may promote the progress of mineralogical knowledge. These directions shall be particularly calculated for drawing the attention of the less experienced, to such specimens as indicate the vicinity of metallic veins or other mineral treasures.

Any person having in his possession minerals, with the nature of which he is unacquainted, may have them examined, or, if of sufficient importance, even analysed, by transmitting them to the Secretary of the Society.

A set of instruments for mineralogical observation or research will be always kept in readiness by the Society, for the use of those who have not such already in their possession, and who may be deemed likely to pursue such inquiries with advantage.

Such are the present objects of the Society, and they will no doubt in time be extended so as to become more generally useful. A fuller statement will, we understand, be shortly published in a Prospectus.

An abstract of the papers already received by the Society shall be given in our next.

XLVI. *In-*

XLVI. *Intelligence and Miscellaneous Articles.*

CURIOUS AND INTERESTING EXPERIMENT.

At Edinburgh, Professor Leslie has just succeeded in freezing quicksilver by his frigorific process. This remarkable experiment was performed in the shop of Mr. Adie, optician, with an air-pump of a new and improved construction, made by that skilful artist. A wide thermometer tube, with a large bulb, was filled with mercury, and attached to a rod passing through a collar of leathers, from the top of a cylindrical receiver. This receiver, which was 7 inches wide, covered a deep flat bason of nearly the same width, and containing sulphuric acid, in the midst of which was placed an egg-cup half full of water. The inclosed air being reduced by the working of the pump to the 50th part, the bulb was repeatedly dipt in the water, and again exposed to evaporation, till it became incrusted with a coat of ice about the 20th of an inch thick. The cup, with its water still unfrozen, was then removed, and the apparatus replaced, the coated bulb being pushed down to less than an inch from the surface of the sulphuric acid. On exhausting the receiver again, and continuing the operation, the icy crust at length started into divided fissures, owing probably to its being more contracted by the intense cold than the glass which it invested; and the mercury having gradually descended in the thermometer tube till it reached the point of congelation, suddenly sunk almost into the bulb, the gage standing at the 20th of an inch, and the included air being thus rarefied about 600 times. After a few minutes, the apparatus being removed, and the bulb broken, the quicksilver appeared a solid mass which bore the stroke of a hammer. The temperature of the apartment was then 54° of Fahrenheit.

In another experiment, with a small spirit of wine thermometer, under the same circumstances and the same degree of rarefaction, the cold produced was found to be $70\frac{1}{2}°$ below nothing, or more than 30° below the point usually assigned for the congelation of mercury.

We understand that Mr. Leslie, from the commencement of these inquiries, confidently expected to be able to freeze quicksilver by such a process. In January last year, he maintained a cold within a degree of mercurial congelation during the space of eight hours; but his air pump not being then in perfect order, and some other parts of the apparatus being likewise defective, he was induced to defer the experiment for some time.

It

It is evident that such prodigious powers of refrigeration, and which will no doubt be further improved, open a wide field for philosophical investigation. Liquids which have hitherto resisted congelation may yet be rendered solid, and gases converted into liquids.

Theatre of Anatomy.—Lectures on Anatomy, Physiology, Pathology, and Surgery, by Mr. John Taunton, F.A.S. Member of the Royal College of Surgeons of London, Surgeon to the City and Finsbury Dispensaries, City of London Truss Society, &c.

In this Course of Lectures, it is proposed to take a comprehensive view of the structure and œconomy of the living body, and to consider the causes, symptoms, nature, and treatment of surgical diseases, with the mode of performing the different surgical operations; forming a complete course of anatomical and physiological instruction for the medical or surgical student, the artist, the professional or private gentleman.

An ample field for professional edification will be afforded by the opportunity which pupils may have of attending the clinical and other practice of both the City and Finsbury Dispensaries.

The Summer Course will commence on Saturday, May the 23d, 1812, at eight o'clock in the evening precisely, and be continued every Tuesday, Thursday, and Saturday, at the same hour.

Particulars may be had, on applying to Mr. Taunton, Greville-street, Hatton-garden.

LIST OF PATENTS FOR NEW INVENTIONS.

To Joseph Cartwright, of Arundel-street, for a material applicable to the manufacture of table and other spoons.—January 28, 1812.

To Marc Isambard Brunel, of Chelsea, for certain improvements on saw-mills.—28th Jan.

To Philip Chell, of Birmingham, engineer, for certain improvements in the methods or means of giving motion to machinery; and also of raising water or other fluids from a lower to a higher level.—28th Jan.

To Charles Grole, of Leicester Place, Leicester Square, for certain improvements in the constructing or making of musical instruments which afford their tones by friction applicable to metallic substances.—28th Jan.

To

To Allen Taylor, of Barking, Essex, for an engine for the purpose of manufacturing all sorts of grain into flour, meal, or any thing else required, which engine may be applied to many other useful purposes.—28th Jan.

To John Leberecht Steinhœuser, of Piccadilly, mathematical instrument-maker, for an improvement applicable to fire-screens, music-stands, or reading-desks, and candelabres.—4th February.

To Samuel Roberts, of Sheffield, silver plater, for his method of making lavers or wash basons of metal much more elegant and useful than hath hitherto been used.—4th Feb.

To Robert Goswell Giles, of the city of London, merchant, for a cap or cowl of a new construction to be placed on the tops of chimneys to prevent the smoke from being driven down by the wind.—6th Feb.

To William Palmer, of Temple Place, Blackfriars Road, in the county of Surry, clerk, for certain piece or pieces of machinery called by him Revolving Rollers and Revolving Roller-wheels, one or other of which may be applied to every sort or description of wheel carriage in addition to, and conjunction with, part or instead of any of the wheels and axle-trees at present commonly used and attached to wheel carriages (as the case may be), and which being so applied will greatly help, facilitate, and render more easy the draught of all carriages.—6th Feb.

To Jeremiah Steele, of Liverpool, distiller, for his new apparatus and method of working the same for distilling and rectifying spirits.—8th Feb.

To Robert Dickinson, of Great Queen Street, Lincoln's Inn Fields; and Henry Maudslay, of the parish of Saint Mary, Lambeth, for their invented process of sweetening water and other liquids, and applicable to other purposes.—8th Feb.

To Thomas Figgins, of Portsmouth, upholsterer, for a couch (which he denominates a palanquin couch) upon an improved construction.—19th Feb.

To George Dollond, of St. Paul's Churchyard, optician, for his improved method of lighting the compass commonly called the binnacle compass used for steering ships at sea, and other improvements relating to ships' binnacles.—19th Feb.

To Louis Honore Henry Germain Constant, of Blandford Street, Portman Square, for his new method of refining sugars.—27th Feb.

Meteorological Observations made at Clapton in Hackney, from March 21, to April 20, 1812.

March 21.—S.E. Fair day, with *cirrus* scattered aloft, and *cumuli* lower; also *cumulostratus* formed. Much cloud by night, with faint lunar *corona*.

March 22.—S.E. Clouds in different stations; fine petroid *cumulostratus* in the afternoon, followed by slight showers: much cloud at night with rising wind.

March 23.—E.S.E. Overcast day; rain, with wind in the evening, which continued through the night.

March 24.—N.E. Snow and rain fell early; the rain kept falling nearly all day.

March 25.—N.E. Snow which fell during night soon melted after sunrise; fair, with light *cirrous* and *cirrocumulous* clouds above flying *cumuli;* some showers of snow fell during the day; the night very clear and cold. The thermometer fell to 28° of Fahrenheit.

March 26.—Very clear morning, the wind N.E.; above it blew another current from the N., and still higher one from the E.; this was ascertained by a small balloon which my brother launched at nine o'clock. The day continued cold with clouds, and the wind became stronger.

March 27.—Cold easterly wind, and chiefly clouded sky, nimbification in some places.

March 28. — Warmer, clouded nearly all day, with westerly wind and gentle showers at times.

March 29.—Temperature increasing, various modifications in different heights; sky chiefly clouded; some light showers.

March 30.—Very warm gale from S.W.; various clouds in different heights, with frequent *nimbi*, one in particular about six o'clock in the evening poured such hard rain that many ditches overflowed and flooded the gardens and fields.

March 31.—Clouded sky, and cool easterly wind again: rain came on in the night, and the wind got to the south.

April 1.—S.W. Overcast and hazy morning; afterwards the haze cleared and the sun came out at times; there were however massy clouds in different heights, and a little rain at night.

April 2.—S.W. Misty and overcast, followed by some small rain.

April 3.—S.W. Hazy, clouded, and windy, followed by some rain; clear evening, with various clouds.

April

April 4.—N.E. Cloudy morning, afterwards fair and calm, with various clouds.

April 5.—Wind very calm and variable; *cumulostratus* prevailed through the day; in the afternoon gentle *nimbi*; a sort of confluent *cirrocumulus* disposed in rows appeared, in the fair intervals, above the *cumulostrati*, which produced rain by inosculation. Birds sing, and gnats and flies appear.

April 6.—Chiefly cloudy and hazy.

April 7.—S.—S.E.—E. Cloudy, followed by rain, but it held up again at night.

April 8.—E. Some rain early; when it cleared, several ill-defined modifications as usual. Clear and very cold night.

April 9.—E. Clear morning; it afterwards became clouded with *cumulostratus*, and other defined clouds; none of the modifications have lately been well marked.

April 10.—Clouds with fair intervals; wind various.

April 11.—Cloudy day; towards evening thick nimbiform haze threatened rain, which however, did not come down; wind gentle and various.

April 12.—E.—W. Cloudy morning, and fair afternoon, with light fleecy masses of *cumulus* apparently diminishing by evaporation, and nearly stationary; lower down fibrous *cirri* passed along in a gentle gale from the west. This is an inversion in the general order of clouds worth notice; in the evening features of *cirrostratus*.

April 13.—Cloudy morning, fair afternoon; clear and cold easterly wind; *cumulus* and *cumulostratus*.

April 14.—Cold easterly wind, rather lofty masses of *cumulus* through the day; in the evening *cirri* passed over from the west, some of them opposite to the setting sun showed a fine red colour: *cirrostratus* also observed; very clear cold night.

April 15.—S.E. This morning a veil of *cirrus* taking on here and there the cirrocumulative form, while *cumuli* of various degrees of density and various figures rolled under. The fall of the barometer and irregular strength of the wind indicated a change of weather; but the day continued fair, and the night particularly clear. The blueness of the sky, however, was not so great this afternoon as in the morning.

April 16.—S.E. Early, a confused veil of *cirrus* appeared spread aloft, while *cumuli* sailed under, and produced *cumulostratus*, which obscured the sky. In the course of the day *nimbi* formed in different places, and a few drops of rain

rain fell at four o'clock. The night became dark and windy.

April 17.—N. Cold wind and much *cumulostratus*.

April 18.—N.E. Cold day; sun out at times: *cumulostratus*, and some *nimbi* which poured a little snow. Flimsy confluent *cirrocumulus* by night.

April 19.—N. Somewhat warmer; loose *cirri* and *cumuli*. By night *cirrocumulus* flimsy and confluent, followed by general cloudiness.

April 20.—N.N.W. Curious *radii* at sunrise, various clouds through the day.

Clapton, April 20, 1812. THOMAS FORSTER.

METEOROLOGY.

Communicated by the Right Hon. LORD GRAY.

To Mr. Tilloch.

SIR,—I have sent inclosed for insertion in your Philosophical Magazine, two Meteorological Tables for last year; the one kept at Gordon Castle, the residence of the Duke of Gordon, the other at Kinfauns Castle near Perth.

I think, a more general publication of such results than what has heretofore taken place, would be of infinite use to meteorological science, by inducing gentlemen more particularly to exert themselves to keep regular journals of the pressure and temperature of the atmosphere; thereby obtaining, in the course of a series of years, a more perfect *average* knowledge, by which to judge of the changes that are to take place in the weather.

I beg to say, that I have His Grace the Duke of Gordon's sanction for sending his Table.

I remain, sir,

Your most obedient humble servant,

Twickenham, April 17, 1812. GRAY.

METEORO-

METEOROLOGICAL TABLE,

Extracted from the Register kept at Gordon Castle, County of Banff, N. Britain, Latitude 57° 38′. Above the sea 100 feet.

1811.	Morning, 8 o'clock. *Mean height of* Barom	Morning, 8 o'clock. *Mean height of* Ther.	Aftn. 3 o'clock. *Mean height of* Therm.	Depth of Rain. In : 100	Number of Days. Rain or Snow.	Fair	West Winds.	East Winds.
January.	29·79	32·64	35·06	1·34	14	17	22	8
February.	29·34	34·57	38·18	2·65	14	14	14	14
March.	29·96	40·93	48·90	0·62	6	25	24	7
April.	29·71	42·90	48·50	3·93	21	9	14	15
May.	29·80	50·90	56·68	3·64	16	15	8	23
June.	29·87	54·93	59·33	0·73	11	19	18	12
July.	29·98	57·90	61·55	2·09	17	14	22	8
August.	29·75	55·10	60·51	4·03	21	10	26	5
September.	29·97	51·50	59·23	2·53	11	19	28	2
October.	29·55	49·13	53·84	4·42	16	15	20	11
November.	29 71	42·36	44·83	2·30	20	10	27	3
December.	29·48	34·64	36·87	3·06	21	10	30	1
Average of the year.	29·74	45·62	50·27	31·34	188	177	253	109

N. B. The S. wind and all to the W. of the meridian are called West.

METEOROLOGICAL TABLE,

Extracted from the Register kept at Kinfauns Castle, County of Perth, N. Britain, for the Year 1811.

1811.	Morning, 8 o'clock. *Mean height of* Barom.	Morning, 8 o'clock. *Mean height of* Ther	Evening, 10 o'clock. *Mean height of* Barom.	Evening, 10 o'clock. *Mean height of* Ther.	Total Rain fallen. In : 100	N° of Days Rain or Snow.	Fair.
January.	29·87	33·19	29·55	33·32	1·45	14	17
February.	29·40	34·83	29·46	34·70	2·63	16	12
March.	30·04	39·80	30·25	39·70	0·90	9	22
April.	29·77	42·90	29.78	40·30	1·91	14	16
May.	29 84	50·03	29.83	47·70	3·12	20	11
June.	29·89	54·60	29·91	51 80	2 20	18	12
July.	29·99	58·01	30.00	55·50	2.86	14	17
August.	29·89	54·83	29·96	52·75	2·71	18	13
September.	30·17	50·45	30·18	50 96	1·78	8	22
October.	29·77	49.54	29·78	49 59	4·41	25	6
November.	29 96	42·50	29·98	42·45	2·97	14	16
December.	29·78	35·03	29·80	34·85	1·80	15	16
Average of the year.	29 86	45·47	29·87	44.47	28 74	185	180

N. B. Kinfauns Castle is the residence of Lord Gray, 90 feet above the level of the river Tay, and three miles almost due East from Perth.

METEOROLOGICAL TABLE,

By Mr. Cary, of the Strand,

For April 1812.

Days of Month.	Thermometer. 8 o'Clock, Morning.	Noon.	11 o'Clock Night.	Height of the Barom. Inches.	Degrees of Dryness by Leslie's Hygrometer.	Weather.
Mar. 27	35	47°	40°	29·80	32	Cloudy
28	42	50	52	·20	0	Rain
29	50	57	50	·49	27	Cloudy
30	52	56	50	·50	0	Rain
31	42	43	42	·52	10	Cloudy
April 1	46	50	49	·50	0	Showery
2	50	55	50	·49	37	Cloudy
3	54	52	46	·47	16	Showery
4	49	50	44	·90	33	Cloudy
5	46	56	45	30·04	45	Fair
6	45	54	46	·08	40	Cloudy
7	46	55	41	29·82	25	Showery
8	40	47	30	30·00	32	Cloudy
9	28	40	33	·00	27	Cloudy
10	34	44	38	29·90	26	Cloudy
11	40	46	40	·88	35	Cloudy
12	42	49	38	·80	45	Cloudy
13	40	47	35	·96	46	Fair
14	40	47	37	·88	35	Fair
15	39	52	40	·69	42	Fair
16	42	46	33	·72	40	Fair
17	35	42	34	·78	43	Fair
18	35	45	38	·96	46	Fair
19	40	46	40	·99	46	Cloudy
20	42	54	40	·98	47	Fair

N.B. The Barometer's height is taken at one o'clock.

XLVII. *Biographical Sketch of the late* MAXWELL GARTHSHORE, *M.D. F.R.S. & S.A. M.R.I., &c.*

IMPARTIAL records of the principles and manners of distinguished characters have long been considered as the writings most beneficial to society. They often unfold those original traits, and even eccentricities, which contribute to modulate or give a bias to the characters of succeeding sons of genius. It has also been laid down as a general proposition, that the literary portraits of such persons should rather be drawn by their friends than their enemies, because good men are much better than even their friends believe them to be, and bad men much worse than even their enemies suppose them. The position will appear more defensible, if we insist on the portrait being sketched from nature, as indispensable to the fidelity of the likeness, and admit that all human judgement is biassed and partial. Hence, in one case the credible portion of good will be related, in another the incredible quantity of evil concealed, and society be equally benefited by the details. The character of the preeminently good, however, still suffers in public estimation; the mass of mankind reluctantly admit the existence of any thing better than themselves, and the general disposition to reduce every thing to our own standard acts as a counterpoise to the ascendency of mere moral goodness. Without, therefore, either attempting or expecting to raise the popular criterion of human character, we shall only endeavour to relate facts, or state opinions, with that simplicity and respect for truth which become the subject.

Dr. Garthshore was born near Kirkcudbright on November 9, 1731 (new style), and died in St. Martin's Lane, London, March 1, 1812. His father was a clergyman of the church of Scotland; he published some detached sermons, which, although perhaps inferior in literary merit to those preached in Scotland at the end of the 18th, are certainly much superior to any contemporary one delivered at the close of the 17th century. That he was a man of learning, talents, and profound piety, cannot be doubted; and the excellent moral principles which he early inculcated in his son were remembered by him with filial gratitude to his last moments. The salutary effects indeed of an enlightened piety, in both father and mother, were happily displayed in the whole life of their son. But these are topics foreign to the nature of this work, which aims at recording only what has reference to human science or art.

The same cause renders it necessary to omit all minute accounts of genealogical or family alliances, and not that they are unimportant in themselves, as most men owe much of the best part of their characters to their ancestors. If any, indeed, despise such things, it must be that their names have never been known, and that they are still unworthy of being known. Against Scots family pride the shafts of licentious satire have often been directed; but till reason finds a better auxiliary to human virtue, cool judgement must acknowledge its expediency, and sanction its tempered existence. While man continues to be influenced by example, "the virtuous son of a virtuous sire" shall always be the glory and the benefactor of his species. Of this truth the deceased was perfectly sensible, but not vain-glorious: its mention, therefore, in this place is rather to illustrate the nature and principle of human action than to indulge in any laudatory reflections on family dignity. The name of Garthshore, it is believed, is now extinct, although it was once known and distinguished in the North. A few years ago the Secretary to the Society of Antiquaries (Mr. Brand) read a curious grant of an estate by an Earl of Buchan to a Mr. Garthshore of Garthshore, a parent of the subject of this memoir. Some of the particulars are recorded among the transactions of learned societies in the Philosophical Magazine.

The education of Dr. G. was marked by that practical solidity which characterizes the Scottish schools. His knowledge of the classic and modern languages was general and comprehensive; and he could read, write, or even speak them with considerable ease and perspicuity. His medical studies were directed by the once celebrated Cullen; but unlike the modern fry of M. D.'s, he did not graduate before learning to reduce his theory to practice with safety, before he had acquired more real knowledge from his own observation than falls to the lot of the majority of London physicians. His reputation for skill, assiduity and humanity had extended over several of the northern counties of England prior to 1764, when his inaugural dissertation * "De Papaveris Usu, tam noxia quam salutari, in Parturientibus ac Puerperis," procured him the Edinburgh academic honours of a doctor of physic. This dissertation is

* Several German writers on opium have quoted this thesis with approbation, and it may be observed that it appeared long before the Brunonian theory had any existence. The salutary effects of laudanum in certain stages of child-bed are now universally admitted. Professor J. C. Starke, of Jena, in 1781 noticed Dr. G.'s opinions of the use of opium, as a respectable authority, in his medical dissertation on this subject.

is dedicated with much gentlemanly good humour and unfeigned respect to his early and unchangeable friend the late Sir George Baker, and does no discredit to the author's head or heart. All his friendships, indeed, being disinterested, were permanent, and he had the happiness of discovering near the same period the talents, and patronizing the merit, of the late Dr. Pulteney, who at his instance obtained an Edinburgh degree without having regularly attended any college lectures. It would, we fear, be a vain effort to look for such exalted principles of friendship among any three living physicians, as what distinguished during their respective lives Sir George Baker, Dr. Pulteney, and Dr. Garthshore. All of them were fortunate practitioners: but Dr. Pulteney realized a large fortune in a country town; Dr. Garthshore distributed one to the poor of the metropolis: the former devoted his leisure hours to botanical researches; the latter to patronize science, and support scientific or humane institutions.

After Dr. G. was established as a practising physician in London (about 1764) and a licentiate of the Royal College of Physicians, he became a Fellow of the Royal Society and of the Society of Antiquaries, the meetings of which he regularly attended, and was not perhaps absent one night, except the two meetings previous to his death, during the last 40 years. His insatiable desire of knowledge and his intellectual energies continued to the last; he read every new publication of merit either on medicine, chemistry, general science or divinity; and he was familiar with all the new discoveries in natural philosophy, anatomy, or the practice of medicine. Many of the modern novelties, indeed, he could trace to their original authors; the curious and obscure work of Wallace on the numbers of mankind, which perhaps gave birth to the famous Essay on the principle of Population, he had examined when writing on "Numerous Births;" and the internal use of cantharides, which has been brought forward as an original discovery in the 19th century, he well knew was ably discussed by Dr. Greenfield, a physician of the 17th, and strongly recommended by him in gleet, leucorrhœa, &c. The revived doctrines respecting the functions of the liver, use of digitalis, sea-bathing, &c. were equally known to him from their original sources. Hence, he was at all times able and willing to avail himself of every thing plausible that was offered as likely to mitigate the sum of human suffering, or improve the healing art. Yet, notwithstanding his indefatigable and extensive

reading, his vast field of observation, his natural promptness and extraordinary accuracy, joined with habits of acute correct reasoning and judicious reflection, he published but comparatively few works on professional subjects. His experience and practice were very considerable, as the relief of the poor deeply engaged his feelings, and drew from him those interesting accounts of "Two cases of retroverted uterus," addressed to Dr. Hunter, and published in the 5th volume of "Medical Observations and Inquiries," 1776; a "Case of difficult deglutition occasioned by an ulcer in the œsophagus;" and of a "Species of erysipelas followed by gangrene which appeared in infants at the British Lying-in Hospital." The last two cases were described in the first and second volumes of "Medical Communications," published by Johnson in 1784 and 1796. His "Observations on extra-uterine cases, and on ruptures of the tubes and uterus," which appeared in the Medical Journal, vol. viii. for 1787; and also a paper read to the Royal Society, and published in its Transactions for that year, on "Numerous Births," demonstrate his intimate acquaintance with both nature and art, his applicable knowledge of all that had occurred in his own practice, or that of his friends or correspondents in Paris, Montpellier, Italy, Vienna, Germany, and St. Petersburgh. But, unlike the modern case-coining physicians of literary notoriety, his time was too much occupied in professional practice, in conscientiously discharging the duties of a *médecin expectant*, to waste it in transcribing and polishing his journals for the press: he was actuated by a different spirit; the recovery of his patient engrossed his whole care and attention, without any regard to literary fame; the production of a flowery narrative, the rounding of a period for some new publication, or multiplied editions of a treatise on a *fashionable* disease (for among the doctors fashion is as paramount as with the milliners and mantua-makers) in order to afford opportunities of repeatedly advertising his name, were considerations very far beneath him. In this age of speculation and adventure such things, however, are too common; but the interests of society require that they should be stigmatized, and that the memory of those who virtuously spurned them should be endeared. The sons of Britain sigh under the dire effects of modern charlatanism; and should the manufacture of physic doctors continue to flourish as it has done of late, all the apprehensions of Mr. Malthus and his votaries, respecting overgrown population, must

must vanish, and sink under the manslaying operations of medical artifice. The sword has cut off its thousands, the doctors their tens of thousands.

But the natural history of medical practice during the last 50 years is too intimately allied with the venerable life of our octogenarian, and too honourable to his talents as a philosopher and his probity as a man, to be wholly overlooked in this brief sketch. Dr. Garthshore lived to see the rise and fall of the spasmodic theory and of antispasmodics, that of the antiphlogistic regimen, phlebotomy, diffusible stimuli, drastic purges, gases, digitalis, and even stramonium! The curative powers of all those sovereign remedies, and many more, which owed their existence to the sanguine imaginations of speculative enthusiasts, have sprung up, flourished for an hour, and sunk to lasting oblivion. While popular attention, however, was occupied with these phantoms, the true indications of nature were entirely neglected, and all our knowledge of her œconomy remained as stationary as if the chemist's laboratory or the apothecary's shop had been the real seat of every disease. Hence the great merit of Dr. G.'s practice, which was peculiar, original, and efficacious far beyond vulgar belief. Well knowing the impotency of drugs, and the imperfection of human knowledge, (which in medicine has not one feature that can aspire to the character of scientific,) he studied nature, identified himself with his patient in family digressions or friendly inquiries, discovered his latent sympathies and idiosyncrasies, ensured his perfect confidence by his suavity and tender attention, engaged his feelings, relieved his mind, and restored him rapidly to health, strength, and improved moral character! In doing this, however, he was far from neglecting any other means which could possibly contribute to the relief of his patient; but he never considered them as alone sufficient, without his own personal care and gratifying attention. The native benevolence of his heart, indeed, impelled him to use every possible resource for the relief of the suffering, and his long experience added to his means, and even to his zeal in applying those means. That he was eminently successful will, we believe, be readily admitted by all disinterested persons capable of judging. Considered as an obstetrician, his talents and success peer above all competition; and he formed a distinguished exception to the truth of the general observation, that all accoucheurs are superstitious. Were we called upon to write an epitaph on his tomb, we should say, "Here lie the mortal remains of

a most charitable and benevolent man, who combined the scientific talents of the philosopher with the exalted purity of the Christian, and cured more patients and killed fewer than any other physician of his age and country." Being a most conscientious man, he was a diffident practitioner, and he always administered powerful drugs or known poisons to his patients with a caution and personal care which, for the sake of humanity, we wish were more generally adopted or universally imitated.

With an active, vigorous, and independent mind, it was not to be expected that he could entertain respect for those corporate bodies which have no internal stimulus but selfishness, no principle of science but puerile innovation, and which are otherwise remarkable only for their rapid transitions from a state of morbid somnolency to that of the wildest enthusiasm or the most scandalous quackery. During his life also he was decidedly hostile to those interested combinations of men ycleped "Medical Societies;" all of which were anxious to insert his respectable name in the lists of their members; but they were often obliged to make very humble apologies for the liberty, and never received from him any sanction in their sordid projects of extending individual practice. To his immortal honour it must be recorded that he never founded nor patronized any such bodies; and all those modern conspiracies against society which are organized by the more ambitious and arrogant to enable them to prey on the more simple practitioners, by assisting them in paying the expense of advertising their names under the mask of Medical Transactions, he conscientiously and openly condemned. Yet, whatever could by any honourable means contribute to the advancement of science, or the improvement of the healing art, invariably and promptly received his active support. It was not in his nature, indeed, to refuse assistance to any measure honestly designed for public utility; but his perception was too quick, and his judgement too correct, to be deluded by any false pretences of visionary good.

As a liberal patron of science his memory will long be cherished by its votaries: his attention to the Royal Society, and his extensive support of the Royal Institution, evinced his zeal in the general cause of knowledge; while his Monday evening conversations, conducted on the most laudable principles, contributed to diffuse useful truths, scrutinize medical or scientific facts, bring philosophers and men of taste into habits of mutual communication, and destroy all those petty jealousies, narrow-minded prejudices,

judices, and envious broodings, which too often disgrace the professional character. For these and many other good services to genuine philosophy every friend of science will heave a grateful sigh to his memory, and at the same time breathe a prayer for the protracted life of his right honourable and steady friend, the worthy President of the Royal Society. Both kept open houses for the learned of all nations, both devoted their lives and fortunes to the melioration of their species, and both have obtained the esteem of great and good men. The patronage of Sir Joseph, indeed, has been much more extensive and more glorious, but could not be more zealous, than that of Dr. G.; and the latter often regretted the inadequacy of his means, which prevented him from being more directly useful to the general progress of philosophy. Even his age did not abate this propensity; but his zeal for science never led him to forget the sufferings of the indigent or unfortunate, and during the latter part of his life he distributed in private charities, and subscribed to humane institutions, above a thousand a year, besides his gratuitous prescriptions and advice to the poor. Nor was this the consequence of instantaneous feeling, the mere impulse of the moment, but a fixed principle of action, the discharge of a Christian duty; and it is now known that at an early period of his life, and when his fortune was very limited, he gave in one charitable donation to the full amount of a year's income! To practise rather than to speak of beneficence was his uniform principle, and his generous heart and hand always gave to the utmost extent that his cooler judgement could approve. His habits of life were the most exemplary and regular. At four o'clock every morning he commenced his studies in his library till a few days before his death: this was the time allotted to write his Diary, which he kept near 60 years. His temperance was scientific, his œconomy the result of rational reflection * and extensive charities to the distressed; and perhaps no physician in London ever contributed so liberally, and with so much extreme delicacy, to the necessities of the widows, orphans, or indigent relations of his professional brethren. So numerous indeed was this class of pensioners, and so liberal was his assist-

* It is possible that there may be some persons ignorant enough to censure him in this respect; but if there be, it can only prove their incapability of discriminating what should be the conduct of a philosopher and a Christian from that of a common *parvenu*. Such, indeed, is the progress of extravagant luxury, that some vulgar minds begin to think it a necessary duty!

 ance

ance to them, that even if the disappointment of dishonest expectations should absorb the noble emotions of gratitude, the painful feelings of their loss must draw forth involuntary tributes to his memory during the remainder of their lives. Viewed as a philanthropist, as a man of talents, whose genuine simplicity and graceful ease made him equally the friend of the poor and of the great, his character rises the more it is investigated; and if we examine his domestic piety, his clear and rational conviction of the great truths of Christianity, we shall perhaps long look for a greater and a better man in any age or country. To youth he was a most able and propitious friend: his meekness rendered him lenient to their foibles, his sagacity anticipated their wants, while his purity checked the recurrence of evil propensities. Had he possessed less virtue, he would have appeared a greater man; had he been more ambitious, vain, or reserved, his reputation might have been higher, but his merits and talents less. Like all conscientious men, he was extremely diffident; in many cases, even with all his knowledge and experience, he hesitated where a forward and thoughtless youth, or an impudent and ignorant quack, decided with all the dogmatism of unprincipled impostors. The horrid sentiment of 'Kill or cure' never once found a place in his mind, as he could find in those cases no such satisfactory evidence of cures as of deaths. He was, indeed, fully sensible of the degraded state of medical practice in the metropolis, as well as the imperfect knowledge of medicine, and he zealously assisted Dr. Harrison in all his attempts in the sacred cause of medical reform. Even the case of a man dying in an English hospital by the bite of a snake, he justly considered as a stigma which every honourable practitioner should labour to remove, by qualifying himself to prevent the recurrence of a similar catastrophe. In this he was consistent, as well as in the whole tenor of his life. His last moments also were worthy of himself; and in the judicious distribution of the very moderate fortune which he left, he did not rob his relations and friends to gratify any posthumous vanity by popular bequests.

A respectable Magazine, in a memoir of Dr. G. otherwise authentic and correct, states, either in consequence of a typographical error or wilful misrepresentation, that the Doctor died worth 55,000*l.* Every person who wishes to know the truth may learn, by applying at the proper office, that the whole amount of his property was only about 35,000*l.*

XLVIII. *An*

XLVIII. *An Account of the Coal Measures or Strata, lately explored, on the Water of Brora, in the Valley S of Clyne, near the SE Coast of Sutherland in Scotland, extracted from Capt.* John Henderson's *Agricultural Survey of the County of Sutherland, just published.*

Coal has been bored for, and found on the banks of the river Brora, on the Sutherland estate, and a shaft is now sinking, to the depth of 250 feet, (a particular account of the strata is annexed,) under the superintendance of Mr. William Hughes, an eminent engineer from North Wales. Salt will be made, as has formerly been done in that vicinity; ironstone may be found, (appearances of it being observed in boring for coal,) and the shores abound with limestone.

Mr. Telford has seen, and given his opinion as to the best mode of searching for, and working the coal at Brora. The work is carried on, (as above stated,) under the direction of Mr. William Hughes, who has had much experience in such undertakings, and has been employed on the Caledonian Canal since its commencement.

Copy of the Journal kept while boreing for Coal at the Water of Brora, County of Sutherland; giving a Section of the several Strata.

No.	Date. 1810.	*Description of the Strata.*	Depth of each Stratum. Ft.	In.
1	Oct. 23	Soft grey stone in thin layers, containing iron-stone balls - - - - - - - - -	6	—
2	31	Soft dark grey sandstone in thin layers, and stones as above - - - - - - -	18	6
3	Nov. 1	Dark, very soft coal metal, in thin layers, with partings of yellow pyrites, and water, which rises to the surface - - - - - - -	2	—
4	15	Dark grey stone in thin layers, with soft partings	6	10
5	19	Dark hard stone with a strong sulphureous smell, perhaps alum shale - - - - -	1	8
6	22	Soft sandy stone, rather lighter coloured than the above - - - - - - - - - -	9	7
7	29	Lightish-coloured sandstone, containing marine petrifactions - - - - - -	14	10½
8		Very hard ironstone - - - - - - -	—	5½
9	30	Hard grey clunch, a common coal-measure - -	2	9
10	Dec. 13	Light-coloured metal stone, rather soft in boreing-	2	6
11	18	Lightish coloured clayish strata soft in boreing, and containing a considerable portion of sparry matter and marine petrifactions - - -	2	9

No.

No.	Date.	Description of the Strata.	Depth of each Stratum. Ft.	In.
	1810.			
12	20	Ditto still darker, containing more of the white spar, sulphureous, effervesces briskly, but does not contain any slack after burning - - -	4	—
13	25	Ditto, light coloured - - - -	11	10
	1811.			
14	Jan. 17	Ditto, still lighter coloured than the above - -	11	2
15	23	Ditto, much darker, containing white powdery matter - - - - - -	11	8
16	28	Dark clunch, a clayish stratum - - -	7	11
17	Feb. 6	Ditto ditto, - - ditto - - - -	4	10
18	13	Very dark coal shale, rather soft in boreing -	2	7
19	20	Ditto ditto - - - - - - -	5	11
20	26	Ash-coloured metal stone - - - -	12	6
21	28	Very hard brown stone, perhaps ironstone - -	—	5
22	Mar. 2	Ash-coloured clunch and bind - - - -	5	4
23	8	Dark bituminous shale, with soft partings - -	7	11
24		Very hard close textured sandstone - - -	—	8
25	April 1	Sandstone with blue streaks, soft in boreing - -	12	9
26	17	Very hard limestone mixed with freestone - -	2	3
27	18	Grey shivery sandstone, rather soft - -	—	6
28	2[illegible]	Sandstone, mixed with limestone, very hard in boreing - - - - - - -	—	7
29	23	Ash-coloured metal stone, rather soft - - -	2	—
30	May 14	Hard caking COAL - - - -	3	3
31	16	Black clunch, pavement of the coal - -	2	—
32	18	Hard splent COAL - - - -	1	4
33		Black-burning shale, like Cannel coal - -	6	7
34		Very hard stone, perhaps ironstone - -	1	2
35	29	Black shale - - - - -	2	—
36		Very hard stone - - - - - -	—	$2\frac{1}{2}$
37	June 1	Soft black shale, speckled with white powdery matter - - - - - -	—	2
38	5	Hard black-burning shale came up in the augur, in large pieces, very promising, and not yet cut through - - - - - -	4	2
		Total depth bored - -	250	$11\frac{1}{2}$

XLIX. *A Sketch of the Natural History of the Cheshire Rock-Salt District.* By Henry Holland, *Esq. Honorary Member of the Geological Society.*

[Concluded from p. 158.]

General Situation, Thickness, &c. of the Beds of Rock-Salt.

Though springs impregnated with salt occur in several parts of the Cheshire plain, it may be remarked that the rock-salt itself has only been worked into, near the banks of the Weaver and its tributary streams. It was first discovered at Marbury near Northwich, about one hundred and

and forty years ago, in searching for coal. This bed of rock was the only one worked for more than a century, when, in the same neighbourhood, a second and inferior stratum was met with, separated by a bed of indurated clay from the one previously known. This lower stratum was ascertained to possess at a certain depth, a great degree of purity and freedom from earthy admixture; on which account, and from the local advantages of Northwich for exportation, the fossil salt is now worked only in the vicinity of this place.

This local limitation of the mines precludes the possibility of many comparative remarks which might be interesting to the geologist; and in giving a particular description of the rock-salt formation, I must confine myself in great measure to the facts which present themselves in the neighbourhood of Northwich, explaining first the circumstances of general position, &c. and then entering into the more minute particulars of the mines which have been sunk into these important strata.

The rock-salt of Northwich occurs, as I have just mentioned, in two great strata or beds, lying nearly horizontally, but on different levels, and separated, the superincumbent from the subjacent stratum, by several layers of indurated clay or argillaceous stone. These intervening beds possess in conjunction, a very uniform thickness of ten or eleven yards, and are irregularly penetrated by veins of the fossil salt. Though the evidence on the subject is not entirely of a positive nature, there seem strong grounds for believing that the beds of rock-salt at Northwich are perfectly distinct from any others in the salt district, forming what the Germans would call *liegende stöcke,* lying bodies or masses of the mineral. It will readily be conceived that there is much difficulty in acquiring precise information with respect to the extent and limitation of these great masses, and that there are many sources of error to which such an inquiry is liable. There are, however, a few leading facts upon which dependence may be placed, and which will be admitted to furnish fair grounds for deduction.

It would appear that the great beds of rock-salt at Northwich assume a general longitudinal direction from north-east to south-west, the line which has been traced upon them in this direction being a mile and a half in length, and no direct evidence existing that they may not extend further in these points; while their transverse extent, as measured by a line at right angles to the former, is much more limited, probably not exceeding in any place one thousand

sand three hundred or one thousand four hundred yards. Several circumstances concur in giving probability to this statement. Let two parallel lines, drawn from NE to SW, with an intervening distance equal to about half their length, be employed to designate the supposed extent of the subjacent rock-salt. In a mine which approaches very nearly to the eastern limit of the area thus formed, the upper bed of rock-salt was actually worked through in an horizontal direction on this side, and discovered to be going off with a very rapid declivity. A similar fact has been stated with respect to another pit further to the south on the same line of boundary; but as the mine was destroyed many years ago by the ingress of fresh water, this statement is considerably more doubtful than the former. It may be remarked too, that in sinking for brine a little beyond, or out of the area, on this side, the brine met with is of a very weak and inferior kind, and at a short distance altogether disappears. Appearances leading to the same conclusion of the sudden termination of the body of rock-salt occur on the opposite side of the area marking its extent. In a mine at the northern extremity of the western line of boundary, a shaft situated nearer to this line is fifteen yards deeper than another shaft immediately contiguous, apparently in consequence of the rapid sinking of the rock-salt at this point. In most of the pits on this side, the upper bed of rock is met with at a depth of from thirty to forty yards; yet at Barnton, a mile further to the west, and on the same or a lower level, none was met with in a sinking of one hundred and fifteen yards.

Corresponding appearances have been observed in the body of rock-salt which occurs at Moulton, between Winsford and Northwich, where in two sinkings on the same level, and at the distance of one hundred yards from each other, the difference in the depth at which the rock was found, was nearly twenty yards, a circumstance from which the limitation or going off of the bed at this particular point may reasonably be inferred. As nothing further, however, is ascertained with respect to the extent and direction of this particular body of rock-salt, I merely mention the fact to corroborate the statement given of the limitation of the great beds at Northwich.

Another important observation with respect to the Northwich rock-salt is, that there seems to be a progressive thinning of the upper bed of salt from NW to SE, or in a direction nearly at right angles to the longitudinal extent of the stratum. Though much uncertainty exists with respect

spect to the rate and progression of this decrease, the general fact seems to be sufficiently confirmed by observations taken from different mines. In those which have been sunk near to the western or north-western side of the area before described, the thickness of the upper bed has been very generally twenty-eight, twenty-nine, or thirty yards. Proceeding towards the east or south-east, we find this thickness decreasing to twenty-five yards, and in the mines near the eastern boundary the bed of rock-salt comes down to twenty, eighteen, and even seventeen yards in thickness. It will be observed that this thinning takes place in a general direction *from* the nearest sea coast; the thickest part of the body of rock being situated furthest down the Weaver, and just above the contraction which takes place in the valley of the river at Anderton.

Besides this general variation of surface in the superior stratum of rock-salt, it has been found that there is a considerable irregularity of level on its upper surface. In one of the mines, in which a tunnel was carried one hundred yards along this surface, many small risings and depressions were met with; and similar appearances have been observed in the other mines near Northwich.

The depth at which the upper bed of rock-salt is found, though varied by several of these circumstances, depends principally, of course, upon the surface of the ground above, which at Northwich, from the confluence of streams there, is somewhat irregular. In the greater number of the mines, it is met with at a depth varying from thirty-five to forty yards. The smallest depth at which it has been found is in a mine situated close to Witton Brook, about half a mile above the entrance of this stream into the Weaver. Here it appears at twenty-nine yards from the surface; and a general estimate of level from this mine shows that the upper surface of the salt is at least twelve or thirteen yards below the low-water mark of the sea at Liverpool; a fact perhaps not wholly unimportant as regards our ideas of the formation of this mineral.

The thickness of the upper bed of salt at Northwich has been already stated to vary from twenty to thirty yards: that of the lower bed has never yet been ascertained in any one of the mines in this district. The workings in this lower stratum are usually begun at the depth of from twenty to twenty-five yards, and are carried down for five or six yards, through what forms, as will afterwards be mentioned, the purest portion of the bed. In one of the mines a shaft has been sunk to a level of fourteen yards still

still lower, without passing through the body of rock-salt. We have thus an ascertained thickness of this bed, of about forty yards, and no direct evidence that it may not extend to a considerably greater depth.

Though only two distinct beds of the fossil salt have been met with at Northwich, it has been ascertained that the same limitations do not exist throughout the whole of the salt district. At Lawton, near the source of the river Wheelock, three distinct beds were found, separated by strata of indurated clay; one, at the depth of forty-two yards, four feet in thickness; a second, ten yards lower, and twelve feet thick; and a third, fifteen yards still further down, which was sunk into twenty-four yards, without passing through its substance. Coal is found and worked within two or three miles of this place*, and the only limestone known in the county of Chester is got from the hills which here form the southern boundary of the plain. In no other parts of the salt district, than at Northwich and Lawton, has the upper bed of rock been worked through.

The strata passed through in going down to the upper bed of rock are nearly horizontal in position, and very uniform in their structure, consisting in every instance of beds of clay and marl; and these, with the exception of a few of the most superficial, appearing in similar progression in each mine. The clays, or argillaceous stone, of which these beds are composed, are indurated in different degrees, tinged with various shades of red, blue, brown, &c. and usually contain a portion of sulphate of lime. They are known to the miners by the general name of *metals;* a distinctive appellation being given to each from the shade of colour which it assumes. In the section of strata, given in my Cheshire Report, these appearances are noted with some degree of minuteness; and that they may more accurately be known, I have sent a few specimens, illustrative particularly of the induration of the clay strata, and of their admixture with the sulphate of lime. It will be observed that, though these clays in general possess a considerable degree of induration, there are some of them sufficiently porous to admit the passage of water through their substance. Where this structure of the clay occurs it goes by the name of the *shaggy metal*, and the fresh water which makes its way through the pores has the expressive appellation of *Roaring Meg*. This term will not appear too strong, when it is mentioned that in the mine from which the section of strata was taken, and where the *shaggy metal* was

* Beyond a great *Fault*, see Mr. Farey's Derb. Rep. p. 147 and 160.—Ed.

found

found at the depth of twenty-six yards, the quantity of water, ascertained to issue from its pores in one minute, was not less than three hundred and sixty gallons; a circumstance greatly enhancing the difficulties of passing a shaft down to the body of rock-salt.

A portion of salt, sufficient strongly to affect the taste, is found to exist in many of these beds of argillaceous stone: and this saltness increases, as might be expected, as we approach the body of the rock-salt. In the strata or layers immediately above the rock, which in all the mines are perfectly uniform in their appearance and structure, it is particularly remarkable. It may be observed, however, that there are not in these strata any veins of rock-salt connected with the great mass below: on the contrary, the line of division between the clay and rock-salt is drawn with great distinctness in every instance, and presents none of those inequalities which would arise from a mutual penetration of the strata.

It may, I believe, be considered as a decided fact, that no marine exuviæ or organic remains are found in the strata situated over the rock-salt. I have indeed heard it asserted that there are a few instances in opposition to this statement; but, upon minute inquiry, I do not find that the accuracy of these alleged exceptions is in any degree to be depended upon.

The general, I believe universal, occurrence of gypsum, in connexion with beds of fossil salt, is a fact worthy of observation. This connexion appears in the salt mines of Hungary, Transylvania, and Poland, as well as in those of Cheshire, and it has led Werner to assign to the rock-salt and flœtz gypsum a conjunct situation in his Geognostic System. The gypsum, contained in the clays over the Cheshire rock-salt, occurs in varying proportions, and under different appearances in the several beds passed through. It is found both in large masses and in small granular concretions. The compact, foliated, and fibrous varieties are all met with; the last of these occurring in very considerable proportion. According to Werner, the first or oldest flœtz gypsum is that which has the most immediate relation to rock-salt. I am not enabled to say whether the gypsum appearing above the Cheshire salt would be considered as belonging to this particular formation. The presence of the fibrous variety of the mineral would rather seem to place it with the second flœtz gypsum where this species is particularly abundant; but no positive distinction can be derived from this circumstance.

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I may remark that gypsum has been met with in several other parts of the Cheshire plain, in situations and with appearances very similar to those in which it occurs above the rock-salt.

Interior Character of the Beds of Rock-Salt.

Having stated the several facts which regard the extent, thickness, and other general characters of the beds of rock-salt at Northwich; I shall now mention more particularly the appearances exhibited in their internal structure, in relation to which some interesting observations occur.

The fineness or purity of the rock is a circumstance very important to the interests of the mining proprietor, and in this point considerable varieties appear in different parts of the strata. The great body of the rock-salt, both in the upper and lower stratum, is composed of crystals of muriate of soda, intimately mixed with certain proportions of clay and oxide of iron, giving to the mass a red or reddish-brown tinge; and, in addition to these constituent parts, contains likewise certain earthy salts, the sulphate of lime, and the muriates of lime and magnesia, but these in small proportion. In every part, however, of this compound rock, we find separate crystalline concretions of muriate of soda, variously disposed, sometimes occurring distinctly in the cubical form; in other places in masses of larger size, and irregularly shaped. The colour of these concretions, which are of the foliated species of fossil salt, is usually a grayish- or milk-white; they are always translucent, and often attain a considerable degree of transparency. It would appear that they contain the muriate of soda in its purest form; the sulphate of lime in specimens of this kind being scarcely distinguishable by the delicate tests applied to its discovery.

This finer rock-salt occurs not only in separate concretions, but also in veins intersecting the coarser mass, and in the rims or borders of the polyhedral figures which will afterwards be mentioned. Its proportion varies both in the two great beds of rock, and likewise in different parts of the same bed; and it is a regard to this circumstance which determines the situation and extent of the workings in the several mines. In the upper bed this variety is less considerable than in the lower: but here the substance of the rock-salt is evidently purer three or four yards above the lower surface than in other parts of the same stratum, and continues so for about four feet. In the lower bed, the first twenty or twenty-five yards passed through contain a pro-

a proportion of earth as large as in the upper stratum: at this depth, however, a greatly increased degree of purity appears, which is continued for five or six yards further down, when the proportion of earthy admixture again becomes as large as before.

It is invariably this purer portion of the lower bed which is at present worked in the Northwich mines, and the rock-salt obtained from it, being principally exported to the Baltic, obtains the name of *Prussian Rock*. The extent of the cavity formed by the workings varies in different mines; the average depth may probably be taken at about sixteen feet. In some of the pits, where pillars six or eight yards square form the supports of the mine, the appearance of the cavity is singularly striking, and the brilliancy of the effect is greatly increased if the mine be illuminated by candles fixed to the side of the rock. The scene so formed would almost appear to realize the magic palaces of the eastern poets. Some of the pits are worked in aisles or streets, but the choice here is wholly arbitrary. The methods employed in working out the rock-salt offer nothing worthy of notice. The operation of blasting is applied to the separation of large masses from the body of the rock, and these are afterwards broken down by the mechanical implements in common use. The present number of mines is eleven or twelve, from which there are raised, on an annual average, fifty or sixty thousand tons of rock-salt. The greater part of this quantity is exported to Ireland and the Baltic: the remainder is employed in the Cheshire district in the manufacture of white salt by solution and subsequent evaporation.

It is very doubtful whether in any instance the body of rock-salt can be considered as stratified, or disposed in distinct layers. A perpendicular section does sometimes indeed present irregular appearances of this kind, and more especially in the purer part of the lower bed; but the great body of the rock offers to the eye merely a confused red mass, varied here and there by the occurrence of the crystalline portions of salt.

One of the most striking facts connected with the internal structure of the Northwich rock-salt, is the appearance observable on the surface of an horizontal section of the rock, as viewed in any of the mines. On this surface may be traced various figures, more or less distinctly marked, and differing considerably in the forms which they assume; some appearing nearly circular, others perfectly pentagonal, and others again having an irregular polyhe-

dral form. The lines which form the boundary of these figures are composed of extremely pure white salt, forming a division between the coarse red rock exterior to the figure, and the equally coarse rock included within its area. These bordering lines or rims vary from two to six inches in width. The figures themselves differ greatly in size; some of them being less than a yard in diameter, others as much as three or four yards; and they very frequently are observed, one within another, gradually diminishing in size to a centre. Professor Playfair, in his Illustrations of the Huttonian Theory, has stated, that the compression of these figures is always mutual; the flat side of one being turned to the flat side of another, and never an angle to an angle, nor an angle to a side. This remark, as far as my observations have gone, is perfectly founded in fact. From the mode of working the mines, it is difficult to ascertain the progressive appearance of these figures in a perpendicular plane. It has been stated to me that their form is a pyramidal one, the area enlarging by a determinate ratio of increase as they are traced downwards; but several circumstances induce me to consider this statement as a very doubtful one, and certainly founded upon insufficient evidence.

One very important negative fact remains to be mentioned with respect to the internal structure of the Cheshire rock-salt, viz. that no organic impressions or remains have ever been met with in any of the beds of the mineral which have been worked in this district. This fact rests on evidence of a satisfactory kind, and I am not aware of more than a single instance adduced in opposition to it, and that of a very dubious nature. The same remark may be applied to the strata of argillaceous stone between the two beds of rock-salt. The veins of rock-salt intersecting these intermediate strata contain principally the fibrous variety of the fossil. It may be remarked too of these strata, that at their junction with the upper and lower beds of rock-salt, the lines of division are nearly as distinct as that between the upper bed of rock and the superincumbent layers of argillaceous stone.

Comparative View of the Cheshire and Continental Salt Mines.

The want of sufficient materials with respect to the history of the continental salt-mines prevents me from entering into circumstances of comparison so minutely as I could have wished; considering such comparison to afford the best

best foundation for inquiries into the origin of the fossil-salt. The best, or rather the only memoir on this subject which I have had the opportunity of seeing, is one by M. Hassenfratz, contained in the eleventh volume of the *Annales de Chimie.* From this memoir it would appear that the general situation of the rock-salt in Transylvania and Poland is very similar to that which it occupies in Cheshire; the beds of this mineral being disposed in small plains, bounded by hills of inconsiderable height, forming a kind of basin or hollow, from which there is usually only a narrow egress for the waters. The situation of the Austrian salt-mines near Salzburgh is however very different. The mineral here appears to be disposed in beds of great thickness, which occur near the summit of limestone hills, at a great elevation above the adjoining country*. This fact is a singular one; and, if we admit the idea that rock-salt is formed from the waters of the sea, makes it necessary to suppose the occurrence on this spot of the most vast and wonderful changes. M. Hassenfratz states it as a general fact, that in countries where salt-mines occur, fragments of primitive rocks appear in great abundance over these beds. It does not seem, however, that any deduction of importance can be connected with this fact.

The disposition of the beds of salt in the continental mines seems to be very generally a horizontal one, and as in the English mines, they are separated by strata of clay of a varying thickness. It would appear, however, with respect to extent of dimensions, that they are in general greatly inferior to the bodies of rock-salt met with in our own island. In Hungary and Poland these beds do not present a thickness of more than one or two feet, and are separated by layers of clay a few inches in thickness. Much, however, it is evident, must depend upon the number of the beds thus disposed, but this I do not find any where noticed. The earthy saline contents of the foreign rock-salt very exactly resemble those of the Cheshire; the gypsum existing in much larger proportion than the other earthy salts, and appearing in considerable masses, both distinctly, and in mixture with the beds of clay. It is an important fact, however, that sea-shells and other marine

* I am informed by Mr. Greenough that the *lapelsgraben*, which is the highest gallery of the salt-mine at Halstadt, is stated in Von Buch's Travels through Germany and Italy to be two thousand nine hundred and seventy-five feet above the sea, and that the salt mines at Hall in the Tyrol are at a much more considerable elevation.

 exuviæ

exuviæ are found in these beds of clay and gypsum; a circumstance which, as I before stated, never occurs in the Cheshire mines. It would seem that the portion of oxide of iron combined with the clay in the substance of the English rock-salt does not exist in the mineral as found abroad, or at least in a proportion not so considerable.

The comparative commercial value of the English and Polish mines is best ascertained by the fact that many thousand tons of rock-salt are annually sent from Cheshire to the parts of the Prussian coast most nearly adjacent to the salt-mines; independently of the large supplies of the English manufactured white salt which are exported to the same country.

Considerations on the Origin of the Cheshire Rock-Salt.

With respect to the theory of the formation of rock-salt, as applicable particularly to that of Cheshire, I shall not venture to say much, and that little will be of a general nature. Though it must be acknowledged that there are some difficulties connected with the supposition, little doubt can exist of the general fact, that the beds of this mineral have been formed by deposition from the waters of the sea. Such an opinion acquires much probability from the situation in which these beds usually occur; occupying the valleys and lower parts of plains which are so surrounded by hills of secondary formation, as to leave only a narrow egress for the waters collected on their surface. This structure of the plain constituting the salt district of Cheshire, I have particularly described; and, regarded in its general character, it leads strongly to the conclusion that the waters of the sea must, at some former period, have occupied the lower parts at least of the basin thus formed, which at that time had a level eighty or one hundred yards lower than the one now appearing*. To account for the great depositions of salt in the lower parts of this basin, it is necessary to suppose that some barrier must have been afterwards interposed to prevent the free communication of the waters of the sea with those thus collected; and the general course of the streams, the position of the beds of rock-salt, and the contractions in the valley of the Weaver, which appear below Northwich at Anderton and Frodsham, point out with some distinctness the place where these obstructions may probably have occurred.

* This general character of the Cheshire salt district was remarked to me by my friend Sir John Stanley, in reference to the formation of the rock-salt; on which subject he obliged me by some very interesting observations, which are inserted in the Cheshire Report.

To

To explain the appearance of the strata of indurated clay, intermediate between the beds of salt, we must suppose that the obstruction still continued, when the deposition of salt from the waters first confined had nearly ceased; and that at this period the deposition of clay, which had hitherto been going on in conjunction with that of the salt, proceeded in a great measure alone; the salt which remained in the water being merely sufficient to form small veins in its substance. When these strata had been deposited to a thickness of ten or eleven yards, it would appear that the barrier preventing the access of the sea to the basin or plain was again so far removed as to allow the entrance of a fresh body of sea water; from the gradual evaporation of which, the formation of the upper bed of rock-salt took place; and there being then no further admission of sea water to the plain, the superincumbent strata of clay and marl were successively deposited in the order in which they at present appear.

This is a general sketch of the probable mode of formation of the Cheshire rock-salt; but as it would seem very doubtful whether any single accumulation of sea water could contain the materials of depositions possessing so great a thickness, the theory might perhaps be successfully modified, by supposing the barrier before noticed to have had such an elevation in the progressive stages of the deposition of the salt, as to allow the very frequent ingress of sea water into the basin. Admitting this idea, we must suppose that the formation of the strata of indurated clay between the beds of rock-salt took place, either during some intermission of these overflowings, or when there was a great predominance of this earth in the water from which the depositions were made. It seems probable too that the veins of salt intersecting these strata were formed rather by the penetration of water holding salt in solution, from the upper bed of rock-salt, than by a direct deposition from the waters of the sea. With respect to the sources of the clay, combined with the substance of the rock-salt, or found in intermediate and superincumbent beds, little doubt can exist that it has been derived from the decomposition of more ancient rocks, of the situation and precise characters of which no vestiges now remain.

This general idea of the formation of the Cheshire rock-salt derives confirmation from the fact that, with the exception of the sulphate of magnesia, the same earthy salts occur together with the muriate of soda in these strata, as are met with in the waters of the sea. The circumstance of the beds decreasing in thickness as they recede from the

 sea,

sea, may perhaps be admitted as another argument in behalf of the opinion.

The principal objection to the theory undoubtedly is, the non-existence of marine exuviæ either in the rock-salt or in the adjacent strata of clay; a fact very difficult to connect with the idea of a deposition from the waters of the sea. Other objections, though perhaps of less moment, arise from the appearance of the earthy salts in smaller proportion in the rock-salt than in sea water; from the apparently partial deposition of the beds, and from the difficulty of explaining the formation of the figured appearances which occur in the substance of the rock. These circumstances, however, will by no means authorize us to reject the general idea which has been given of the origin of this mineral, strengthened as it is by the situation and appearances observed in the foreign salt mines, where the proofs of marine deposition are still stronger than those presented in the Cheshire district.

I confess I see no sufficient reason for supposing the action of subterraneous or internal heat in the formation of the beds of fossil salt. It appears probable that a deposition of muriate of soda from the confined waters of the sea might have taken place without the intervention of this agency, and there are no appearances either in the beds of salt, or in the clays accompanying them, which render it necessary to have recourse to the supposition in question. It must be acknowledged, however, that it is difficult to give a satisfactory account of the consolidation of the beds of salt; nor do I know any opinion on this subject, which can be considered altogether free from objection. A more enlarged discussion of these theoretical points may be found in the Appendix to the Report of Cheshire, before alluded to.

In dwelling thus minutely upon the natural history of the Cheshire rock-salt district, I am not aware that I have gone further than was requisite to a complete view of the subject. The prosecution of such inquiries is much assisted by the comparison of facts observed in different situations; and as the neighbourhood of Droitwich, in Worcestershire, is, with the exception of the Cheshire salt district, the most considerable source of brine springs in this kingdom, some information with respect to the situation and natural history of these springs, as connected with a subjacent body of rock-salt, may be considered a desirable and important object. Such information I have not the means of giving; but it is more than probable that the Geological Society will be enabled to procure it, by the assistance of some of its corresponding members.

Section

Section of the Strata sunk through to the second Bed of Rock-Salt at Witton, near Northwich.

No.	Nature of the Strata.	yards	feet.	inch.
1	Calcareous Marl	5	—	—
2	Indurated red Clay	1	1	6
3	Indurated blue Clay with Sand	2	1	—
4	Argillaceous Marl	1	2	—
5	Indurated blue Clay		1	—
6	Red Clay, with Sulphate of Lime irregularly intersecting it	1	1	—
7	Indurated blue and brown Clay, with grains of Sulphate of Lime interspersed	1	1	—
8	Indurated brown Clay, with Sulphate of Lime crystallized in irregular masses, and in large proportion	4	—	—
9	Indurated blue Clay, laminated with Sulphate of Lime	1	1	6
10	Argillaceous Marl	1	1	—
11	Indurated brown Clay, laminated with Sulphate of Lime	1	—	—
12	Indurated blue Clay, with laminæ of Sulphate of Lime	1	—	—
13	Indurated red and blue Clay	4	—	—
14	Indurated brown Clay, with Sand and Sulphate of Lime irregularly interspersed through it. The fresh water (360 gallons per minute) finds its way through holes in this stratum, and has its level at sixteen yards from the surface	4	1	—
15	Argillaceous Marl	1	2	—
16	Indurated blue Clay with Sand, and grains of Sulphate of Lime	1	—	9
17	Indurated brown Clay, with a little Sulphate of Lime	5	—	—
18	Indurated blue Clay, with grains of Sulphate of Lime		1	6
19	Indurated brown Clay, with Sulphate of Lime	2	1	—
20	The first Bed of Rock Salt	25	—	—
21	Layers of indurated Clay, with veins of Rock Salt running through them	10	1	6
		76	2	9
22	The second Bed of Rock Salt, which has been sunk into 35 or 36 yards.			

See the engraved Section in the Agricultural Report of Cheshire.

L. *On Gypsum near Doncaster, and Nodules of Limestone, and of Pyrites containing Sea Shells, in the Coal district near Bradford in Yorkshire. By a* Correspondent.

To Mr. Tilloch.

Sir, Desirous of contributing my mites towards the interesting and important Geological investigations in which your Correspondent Mr. John Farey is engaged, I beg the favour of you to state for his information, and that of your other Geological readers, that to the places where *Gypsum* is found between the Yellow Lime Rocks, mentioned in your present volume, page 105, that in line 7 from the bottom may be added, after Edlington, "Marr $1\frac{1}{2}$ *m.* S (Gypsum quarries);" these Hall plaster Pits are situate about $\frac{7}{8}$ *m.* W of Cusworth, nearly W of Doncaster, in this county.

I beg also to mention, with reference to the 3d Coal-shale of Mr. Farey's Report on Derbyshire, whose course or basset edge, between the 3d coarse Grit Rock, and the 4th fine lamellar Grit or Paving Rock, is briefly traced through this county in your 102d page, that Mr. James Sowerby in the last monthly number of his "British Mineralogy," plate 455, has figured and described the nodules of pyrites or brasses found immediately above the Coal, in Sir Joseph Banks's Colliery at Alton in Derbyshire, and again at Whitley Wood in Sheffield Parish, that so remarkably abound with the *Ammonites Listeri* and *Anomites resupinatus* of William Martin, and other shells; and mentions, that nodules of black Limestone containing similar shells so abound just above the Coal, near Cathrine Slack, 2 *m.* N of Halifax, that a kiln is erected to burn them into Lime; yet that specks of pyrites are seen in such Limestone Balls, and some shelly balls, are all pyrites, found at that place, but particularly so at other Collieries to the NE and E, as the stratum ranges, E of Idle, near to Calverley, and Farsley, across the Air to the S of Horsforth, &c. I very much wish that your Readers and Correspondents in these parts, would send you particulars of every like occurrence of fossil shells in the Coal-measures, as being a very curious and important phænomenon*. I am yours, &c.

Yorkshire, 15th April 1812. F. O. E.

* With regard to the question, p. 99, line 16, whether Red Marl is the immediate upper stratum to the Durham magnesian Lime Rock, I would mention, that I have heard, that at Hartlepool there is a Grit-stone Rock, in very thin lamina, in some parts of it, and others take a good polish, perhaps owing to a calcareous cement.

LI. *Geo-*

LI. *Geological Observations on the County of Antrim, and others in the North-east Part of Ireland, in an Attempt to arrange the numerous Facts, stated by* Dr. William Richardson *to the Royal Irish Academy, and to the Royal Society, and those recently published in the Rev.* John Dubourdieu's *Statistical Survey of Antrim, by* Dr. William H. Drummond, *in the Preface and Notes to his Poem "The Giant's Causeway," &c. and to refer each of them to one of four principal Strata; separating such as belong to the Alluvia: with incidental Facts and Observations respecting other Districts, &c. &c.* By Mr. John Farey *Senior, Mineral Surveyor.*

[Continued from p. 282.]

Fourth,—I may now I think proceed to mention, that I consider Drumglass, Dungannon or Tyrone Collieries, at no great distance from the SW corner of Lough Neagh, and near 300 feet I believe above its level, with a rapid NE dip, to be in measures above the great Basaltic Rock, that under-lies Lough Neagh: whether these Coal-measures form a limited patch, or hummock on the western slope of my grand Trough? or, whether they are the exposed part of more extensive carboniferous strata, covered in general by alluvia or Bog? I submit to the decision of the able observers, which I am so glad to find, that our sister Island can boast: I would however further remark, that 48 feet of "Clay and rubble stones," being found on the Drumglass Coal-measures, according to Mr. W. p. 246, these alluvial stones, according to Mr. G.'s notes, consisting of rounded Limestone, Granite, and other stones, seem to favour the latter supposition, especially, as Coal-measures are intersected and shown by the Blackwater Valley, for half a mile above Benbervin Mill, near Clonfecle; that Coals have been dug at Maydown $\frac{1}{2}$ *m.* E of this, that near Newry on the Keady Road, a substance has been found "much resembling Coal in appearance," though "in a primitive Country," Granite being found at Newry, and there are appearances within half a mile of Banbridge in Down, that induced English and Scotch Colliers to try there for Coals, (Mr. G.'s Notes;) all this I think tends to show, that the Coal-measures S of Lough Neagh are not of such small extent as some have supposed, though much concealed by Gravel and Bog, and by their upper strata of Whinstone, Limestone, &c. probably.

The

The Ballycastle *Coal-measures* may have appeared to Mr. D. to be *elevated*, from his saying p. 75, that " the *Sandstone*, which may be traced from the southern to the northern extremities of the country, and which seems to be the body, on which all the other strata rest, is here out of its usual level, being as it were forced up from its natural place and hemmed in by Basalt, which it equals in height:" which is founded it will be seen, on the supposed identity of sand-stone (but which of them?) in the Coal-measures, with that in the Red Marl, page 273 herein, at the SE extremity of the County. I think, on the contrary, that a great *fault* or Gaw might be traced, from somewhere near the mouth of the Ballycastle Valley*, eastward to the coast, and that the corner of the trough and of the Island beyond this, has *sunk* (or the other been raised, who shall say which?) very many hundred feet.

Dr. Hamilton's account of these Coal-measures, taken from the basset edges in the sea cliffs, for they have no deep shafts, but use Galleries or Drifts only, as given by Mr. D. p. 86, is as follows; viz.

" Ballycastle strata, above and under the present working Coal, at *Gobb Mine*, by John Evans, miner.

	Yds.	ft.	
Whinstone	20	0	This is the same stone (see page 269, herein) as the Basalt of Fair-Head, and is imperfectly columnar.
Floating Slate	8	0	
Yellow Freestone ...	14	0	
Slate and *Coal*	7	0	
Hard gray Freestone .	30	0	
Present working COAL	1	2	
Slate, or Coal Seat ...	0	2	
Coal	0	2	
Boarding and Slate ..	6	0	
White Freestone	12	0	
Coal and Slate	1	0	
Gray Freestone	12	0	
Shivery Freestone ...	7	0	Thus far the disposition and thickness of the strata appear to be marked with
Carried forward	120	0	

* Perhaps this fault, in one or more straight lines, or near it, may range yet further south, since Dr. R. mentions, that " the *Freestone* strata on the north-west face of the mountain Bohul Bregagh, above Ardmoy, afford some indications of *Coal*."

tolerable

	Yds.	ft.	
Brought forward	120	0	tolerable exactness, so far as may be judged by looking at the face of the precipice. It is difficult to observe, with accuracy, the lower strata, because of the rubbish, covered with an imperfect vegetation, toward the base of the cliff.
Slate	0	2	
Yellow Freestone ...	10	0	
White *Limestone* ...	1	2	Grayish Limestone, abounding in marine Shells, occurs hereabouts.
Coal	0	$1\frac{1}{2}$	
White Freestone	3	0	
Blue Bind	1	2	
Sandstone Bind	1	2	
Main *Coal*, covered by the Sea	6	0	This is not known to the present workmen."
Yards ..	145	$0\frac{1}{2}$	

In the above account by Evans, it will be observed, that Slate means *Shale*, Freestone means *Grit-stone*, in the language of the Derbyshire Colliers, and that the Notes in the last column seem by some one else, whether Dr. H. or Mr. D. does not appear.

Mr. Whitehurst gives no measures to the 14 strata which he enumerates (page 260); and the order and denominations so materially differ from the above, that further and more precise observations seem much wanting, in the lower part of the series particularly. Mr. W. if his scale has any proportionality in it, shows the Limestone to be about eight feet thick, and calls it "brown, containing no marine shells:" his lowest stratum (under a considerable space of unascertained strata) wholly below high water, he calls "Millstone Grit, containing quartz pebbles, perfectly similar to stratum, No. 1, in the Derbyshire Section;" my 1st Grit Rock, and if so, is a very coarse Grit or Sandstone.

Several *whynn-dykes* intersect this Coal-field, five of which Dr. R. has described in your 35th vol. p. 372, &c. These dykes, all here have the nature of *faults*, in depressing the strata, on the west side (Dr. R. vol. xxxv. p. 374); at Whaley's Folly one of them separates bituminous or blazing Coal, from blind or non-inflammable Coal,

Coal, or stone Coal, which has lately begun to be worked: *Ironstone* is found above the Coal here, Mr. D. p. 75: the dip is easy, to the south, p. 76: some of the levels are 900 yards long; a bed of Coal has been worked, by pumping, below the level of the sea, p. 77: 100 men are daily employed in these works, p. 78, and as might I think from their number, be expected, are rather "lazy and indolent," p. 80. Fine *Potters' Clay* is found near Fair-Head, *Brick-clay*, excellent *Firestone*, *Scythe-stones* of the best quality, and *Glass Sand*; and Quarries of excellent *Freestone* are wrought in these measures, pages 84 and 85. Near Ballycastle there is a *Chalybeate* spring, and another S of it near Knocklaid Mountain: and an aluminous vitriolic spring near Ballycastle, p. 138.

At Brachaville near Coal-Island northward of Dungannon in Tyrone, the measures, according to Mr. G.'s Notes, are as follows; viz.

	Yds.	ft.	in.
Sand	8	0	0
Craw *Coal*, with metal covering it, 18 inches	2	0	0
Clay and white Stone, &c.	8	0	0
Coal	0	2	4
Fire Clay, hard Clay, Black Bind, and white measures	17	0	0
Main *Coal*	2	0	0
	37	2	4

Thirty yards deeper, they come to another *Coal* three feet thick (the yard Coal), but it is sulphureous and full of water, and therefore now little worked, though it runs regularly through the Country: it dips one yard in five and has a good roof.

Under the west façade of Fair-Head NE of Ballycastle, Mr. Davy, when visiting Dr. R. found *blue Limestone*, App. p. 30, which further shows the variety, in the lower and unexplored part of these Coal-measures; to which I think may probably be referred, the "small eruption of white Limestone near Templepatrick," in the interior of the Basaltic district, App. p. 25, and the "similar eruption near Broughshane," p. 26; of the first of these Mr. D. says, p. 69, that from the quantity of silex which this stone contains, it will not answer for making lime; and I think it vastly more probable, that these are remains of the lower part of the Coal-measures, resting on the Basalt, than parts of its understratum, elevated 1200 feet or more; to say nothing of the dissimilarity of the substances.

stances. The "*micaceous Limestone* found at Toberbelly near Ballycastle, which makes good Lime for mortar or for manure, and is of the same quality with that used at Dalmully in Scotland," Mr. D. p. 68, probably belongs to these measures. The *gray Limestone* commencing at Loughgall in Armagh, Mr. D. p. 39, is probably that extending to the neighbourhood of Armagh Town, already mentioned page 281 herein, and belongs to the lower part of the Coal-measures, *on* the great Basalt and not below it. The notes of Mr. G. represent the Coal-field in Tyrone, as bounded on the NW, by Limestone at Ruchan; that Benbervin Castle stands on Limestone near the Blackwater River not far from Clonfecle, and that three or four alternations of Limestone, Freestone and Coal-shale appear, near that place; that at Desamartin in Derry, there are very large lime-works in a bluish-gray Rock (not white), and smaller quarries of the same sort of stone at Cookstown in Tyrone.

The *Sandstone* which occurs "between Broughshane and Clough, near the centre of the County," Mr. D. p. 91, probably is the remains of the lower part of the Coal-measures below the Coal-seams; and so may the same in Rathlin or Raghery Island, Mr. D. p. 91, since I have not heard of the actual existence of Coal seams there?, a point on which I wish information, and of their position with respect to the Basalt, if such appear.

Fifth—Alluvia or Water-moved and worn superficial matters, in your 33d volume, page 199, Dr. R. speaking of a tract immediately to the southward of Kells and Connor says, "we here find a district near four miles in diameter, called the Sandy Braes: over this whole space the basaltic stratification *has been carried off*, and the operation has reached deep into a very singular substratum, a reddish *Breccia*, by some mineralogists called a *Porphyry*, the mass friable, but the component angular particles of extreme hardness. The Hills, of which this little district is full, are every one perfect segments of spheres, while the loftier basaltic hills that surround it, preserve their characteristic form, to wit, a gradual acclivity on one side, with a steep abruption on the other." In Mr. D.'s App. p. 33, Dr. R. says that this Breccia is an excellent material for Roads, and frequently contains *Opal*; at p. 49, nearly the same is repeated; to me notwithstanding, the evidence seems defective, of these knowls belonging to any *regular* stratum, but the probability much stronger, of what Mr. D. states, page 34; viz. that they are *Gravel*, (or rather I should say, rubble knowls, the stones being angular, of extraneous alluvia), and

and he considers them as allied to the gravelly ridges, common in the south of the County, p. 34, particularly that extending from Dunmurry to near Magheragall church, p. 24.—I should inquire, does this singular breccia appear in a ring, at the foot of the hills surrounding the denudation? as it ought to do, and pass under them on all sides? and what is the stratum *under* these knowls?; in short I fear, that the Doctor's zeal has here led him a little too far, in applying a favourite theory: while in enforcing the fact, of a denudating agent having very generally *acted from above**, in his district (vol. xxxiii. p. 204), he seems not to have been aware of one of the most conclusive evidences of its truth, that of faults or *depressions of the strata not occasioning a corresponding step or inequality in the surface!* and though much struck with the derangement of 30 or 40 feet in the face of the façade near Port Spagna, vol. xxxiii. p. 106 and 197, vol. xxxv. p. 371, and others in the Coal district, pages 372 to 374, it does not seem to have occurred to the Doctor, to have traced any of the lines of these faults from the edge of the cliff and *along the surface of the land*, as in the Coal district would easily be done by the information of the Colliers, as to where they have

* Dr. Drummond, on the very incontestable evidence which Dr. R. has advanced to prove, not from a solitary spot but from a Coast of 60 miles in length, and the greater part of *the surface* of the country which it bounds, that a force *acting from above* has torn or carried off the greater part of the upper strata (and into which evidence Dr. D. carefully declines entering), treats the Reader of his Poem with the following remark: "What," says he "this cause was, the Doctor leaves his readers to conjecture, and he is decided that it was neither fire nor water. Was *the tail* of Whiston's comet the besom of destruction, with which our valleys were swept?"—All this, and much more that precedes and follows, may serve to amuse, and to prove, how much easier it is to give mineralogical *names* to substances, without hesitation assign their order of superposition, unsight, unseen, according to "The Geognosy," and to write verses, than it is to make Geological observations, and to reason thereon, in the able manner that Dr. Richardson has done.

Though compelled thus again to flatter Dr. R., as he is pleased to term it, in Mr. D.'s App. p. 51, I cannot acknowledge much fresh obligation, on account of his inventing a denudating cause *for me*, of which I never spoke or thought in my life! and there publishing it, viz. "that one of the *diminutive* and newly discovered *Planets* has, in some of its revolutions, come so near to our Globe, as to have changed the direction of gravitation, and, in its *rapid progress close to our surface*, to have carried off the materials we now miss;" an opinion, so demonstrably contrary to the possible reciprocal actions of *Planets* on *each other*, or of *Comets* on *Planets*, that I should be truly ashamed of it, and introduce it here, only to disavow it; wishing now, as I have done in my Derbyshire Report, to employ myself with facts and visible effects, and adjourn the discussion of *causes*, perhaps, until Dr. R. shall have more extensively succeeded, in silencing the supporters of false theories, against which he has so nobly commenced hostilities:—now and then I may perhaps find opportunity, to furnish him with a little ammunition, from my stores.

proved these beneath, (confirmation of which might be easily obtained, from the principles laid down in my Derbyshire Report, i. 129, and your 33d vol. p. 263), and to have shown, that none of these derangements materially affect the form of the surface, but that what remains to complete the pile on the sunk side of a fault, is, as in the case of the numerous hummocks, the proper and undisturbed upper strata, that on the other side the line of fault, are carried off and gone!; all this I cannot doubt but he might have shown, from my undeviating experience, and that of all the many practical Colliers with whom I have conversed: but I caution Dr. R. against suffering modern *slips* of piles of strata, either into the Sea or the valleys, from being unfairly urged as objections to this most astonishing and important Geological fact, with which I believe no theory-maker before my time was acquainted, or if so, they seem culpably to have suppressed it.

On a subject connected herewith, I cannot help again noticing the seeming inconsistency of Dr. R. with respect to the slight *Tablets* of *hard* Strata, if not "Stony ridges," to be seen and most assiduously attended to, in surveying denudated districts, as I have mentioned, vol. xxxiii. p. 262; and which he seems fully to admit, in the mention of these stony ridges, vol. xxxiii. p. 107 and 109: and their effects on the outlines of the summits, or dorsa, of long ridges, Mr. D.'s App. p. 43: and again, "the form of our surface, and the shapes of our hills, depend more than we are aware of, on the materials composing them " App. p. 49: and yet, the improper manner of expressing the 3d of Dr. R.'s Geological facts (vol. xxxiii. p. 112) "and our *surface* itself are unconnected with, and *unaffected by* the arrangement of the strata below them," remains yet uncorrected, and in Mr. D.'s App. p. 40, Dr. R. even says, that an observer "finds the arrangements of the component strata have *not the slightest influence* on the *form* of our surface: that its figure is governed by their removals, not their positions; that the materials which once formed it, have been carried off *irregularly and, for aught we can see, capriciously*." What! could not the writer discover indelible marks of infinite *wisdom* rather than caprice, in the almighty sculptor of the Antrim stratified block? (to use his own excellent metaphor, App. p. 41, 46, &c.), which has so fashioned its diversified or "collivallian" surface, that scarcely *any part thereof* can be found, without *a connected descent for all the waters from its surface!*

The stony Ridges, or edges and parts of the tops, of harder

strata

strata than the general mass, which I have mentioned above, would well employ the attention of Dr. R. and other observers in Antrim, where I think, while inspecting Mr. D.'s *Map*, that I can perceive clearly their influence, in separating the long and wide stripes of *Bog*, with which the western side of that County, from Lough Neagh northward, is unfortunately encumbered: and that such stony ridges, might be traced northward to the top of the cliff, and into its face, to the façade which Dr. R. has so well described vol. xxxiii. p. 104.

The readers of your 36th volume, p. 361 and 437, will have noticed, besides some important facts, as to the natural history of the extensive *Bogs* or Peat Mosses of Ireland, that our legislature had seriously entered on a scheme for effectually *draining*, in order to aid the *cultivation* of the main of such Bogs: and I embrace the opportunity here of mentioning, that Dr. William Richardson, having long turned his attention to these Bogs, and to the making of accurate observations and discriminations, as to the causes and nature of Bogs and Fens, and the different steps to be taken for the improvement of each, some time ago prepared a long and excellent Memoir on the subject, which is now printing (for the first time) in the numbers of the *Agricultural Magazine** (published by V. Griffiths, No. 1, Paternoster Row), in which nearly the whole of the most expensive steps now pursuing under the Act of Parliament for the above purpose, are decidedly and as I think, justly condemned, as useless and indeed hurtful some of them, if persisted in: it is a subject that has fallen somewhat under my cognizance, ever since the quackeries of the late Mr. Elkington first engrossed the public attention, and on which I have enlarged rather, in the chapter on Draining in the remaining part of my Derbyshire Report, now in the press.

I should

* Dr. R. will excuse my correcting an inaccuracy in vol. x. p. 67, of this work, in mentioning the Fens of *Bedfordshire*, since there are none such. The name "Bedford Level of the Fens," situate in Cambridgeshire, a great many miles from Bedfordshire, and so called in compliment to an Earl of Bedford who patronized their embankment and drainage, has probably misled the Doctor, as it has before done others.

Among the important facts with respect to the Irish Bogs which Dr. R. gives us, is that of their not immediately resting upon *Clay* or *Marl*, as represented vol. xxxvi. p. 367, 371, and 443; but that in every one of the numerous places which he had examined, "a tough, viscid, ponderous, and whitish Earth, which when analysed (says he) by my scientific College friends (in Dublin) gave *eighty-three parts of silex*, sixteen of alumine, and one of oxide of iron." Agr. Mag. vol. x. p. 81 and 144, was found immediately under the peat: and which confirms the observations of Mr. Wm. Smith and myself during near 20 years past, that though Fens and Marshes, and some

I should not quit the *Alluvia* of Antrim without mentioning, that Mr. D. p. 21, represents a clayey *Whynstone Gravel* as prevalent on the plains and valleys. That a considerable tract of alluvial *Sand* is found at Shane's Castle and other parts of the shores of Lough Neagh, p. 24 and 111: and whence probably, the variegated *Calcedony* pebbles, p. 110, are derived: a clayey Gravel near the Crumlin River, two miles from its mouth, contained a mass of partly *petrified* wood weighing 700 lbs., the outside being stone and parts of the interior still wood, Mr. Barton, p. 51 and 100; at Tradubach Bay on Lough Neagh, a piece weighing 200 lbs., wood outside and stone within, Mr. B. p. 99; at Ahaness 1 *m.* S of the river Glenavy, a piece 150 lbs. weight, now probably in the Museum of Trinity College, Dublin, Mr. B. p. 96, and Mr. D. p. 109, Note. On the Six-mile River two miles from Lough Neagh, specimens are found, as much as a man can carry, the outsides of which are wood, Mr. D. p. 55, and in other places wood which has undergone no change, Mr. B. p. 59; specimens of petrified wood being found in Gravel, eight or ten miles distant from Lough Neagh, Mr. B. p. 103: see also Mr. D.'s account of the above, pages 105 to 111. *Lapis syringoides* are found in Derry on the shore of the Lough, Mr. B. pages 74 and 75, perhaps the petrified *Coralites* of Mr. D. p. 109. *Hazel Nuts* petrified, are thrown up occasionally, by the waves of the Lake or Lough, Mr. D. p. 109 and 110, but whose *waters* are denied the wonderful properties which ignorance and credulity had assigned them: Mr. B. shows, p. 130, that the petrified wood is not so generally *Holly*, as had been asserted. At Ahaness a stratum of *bituminated Wood* under blue and red Clay is found, Mr. B. p. 97 and 130, and in other places bordering on the Lough, Mr. D. p. 90.

some Valley Bogs, rest on Clay or any other substances, within the Level of the obstructions to the retreat of the Waters *which occasioned them*, yet real Bogs and Mosses such as those in Derbyshire (which I first examined near Buxton, in 1797) perhaps invariably, rest on *Sand*, Grit-stone, or sandy loam, as mentioned in my Derbyshire Report i. 307, 308 and 312; and in which respect, the present aquatic vegetables of our Bogs, seem to differ materially from the immense subaqueous crops of *extinct races of plants*, which occasioned our *Coal-seams*; which, according to my extensive observations and inquiries among the practically informed on this subject, invariably rest, immediately (however thin it may be), on infusible or *Fire-Clay* in some of its various states of induration and perfection, as mentioned in my Report i. p. 179; and into which fact I hope that Dr. R. will minutely inquire, in the Collieries of Antrim and Tyrone, &c.: as also, what is the exact direction of all the *slines* or length-way vertical joints in the Coal-seams, in those various Collieries? Do they range ESE and WNW, as in and near Derbyshire (Report i. 181), or in any other invariable direction?

A *Quartz Crystal* weighing 30 lbs. was found in loose earth, probably alluvial, on Knocklaid Mountain S of Ballycastle, Mr. B. p. 178 and 209, and another weighing 2 lbs. 2 oz., with numerous smaller ones, on the alluvial shores of Lough Neagh, with *Mocoa* stones, *Cornelians*, at the SE corner of the Lough in particular, Mr. B. p. 78, 105, and 173; *Topazes* and *Amethysts*, p. 175, and some of the last species of stone at 15 *m.* distant from the Lough, Mr. B. p. 172.

"*Limestone Gravel* exists in many parts, at Ballinderry near the Corn Mill in the River Dumart, also at Portmore Park in the parish of Glenavy," Mr. D. p. 68.

I cannot dismiss the valuable statistical Survey of Antrim, without lamenting, that Mr. Dubourdieu has not added a copious *alphabetical Index* to it, which would greatly have increased its usefulness, as the depository of so many facts interesting to the Naturalist and Œconomist.

Dr. Drummond announces, (preface p. xxvii) that his friend *Dr. Mac Donnel* has in hand a work, giving a detailed and satisfactory account of the mineralogy of the County of Antrim: to this gentleman, I may hope, that some things herein may not prove devoid of interest and use.

I am, sir,

Your obliged and very humble servant,

JOHN FAREY Sen.

12, Upper Crown-Street, Westminster,
March 25, 1812.

LII. *Description of an improved Pump for raising the Water while Shafts or Pits are sinking.* By Mr. WILLIAM BRUNTON, *of Butterley Iron Works, Derbyshire**.

SIR, I BEG leave, through you, to lay before the Society for the Encouragement of Arts, Manufactures and Commerce, drawings of a pump upon an improved construction, for the purpose of raising water from pits, whilst they are sinking. Before I enter upon an explanation of my plan, it will be requisite to state those inconveniences arising from the common mode, which are intended to be obviated.

First, as it is necessary for the pumps whilst sinking, to be always working upon air, that the water may be kept

* From *Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce*, for 1811.——The silver medal of the Society was voted to Mr. Brunton for this communication.

very

very low in the pit, the engine of course frequently goes too fast, and carries up by the violence of the current small pieces of stone, coal, or other substances, and lodges them above the bucket, which must considerably retard the working of the pump, and wear the leather.

Secondly.—When the engine is set to work, (after having been stopped whilst working upon air, and consequently a quantity of air remaining in the suction-pipe, with the small stones, &c. deposited on the valves of the bucket,) it often happens that the compressure of the air by the descent of the bucket is not sufficient to overcome the weight of the bucket valves so loaded with rubbish, and the column of water in the stand pipes, the pump is hereby prevented from catching its water; the usual remedy for which is, to draw the bucket out of the working barrel, until a quantity of water has escaped by its sides, and displaced the air. Observe here, that this often happens from the unnecessary magnitude of the space between the bucket and clack.

Thirdly.—The pumps are suspended in the pit by capstan ropes, for the purpose of being readily lowered as the pit is sunk; the stretching of the ropes (especially when sinking in soft strata) occasions much trouble, by suffering the pumps to choke; but the most serious evil is, that the sinkers, in shifting the pumps from one place to another, throw them very far out of perpendicular, thereby causing immense friction and wearing in all the parts; besides endangering the whole apparatus, by breaking the bolts and stays, and straining the joints.

Fourthly.—As the pumps sink, the delivering pipe at the top is raised, by putting on short pipes, generally about a yard at a time, which occasions many stoppages and much hinderance in the work.

Having an engine pit to sink at Codnor Park Colliery, Derbyshire, belonging to the Butterley Iron Company, I endeavoured to obviate the difficulties stated; and, first, for the purpose of preventing the pumps working too much upon air, I constructed a working barrel, (which in this case was nine inches diameter,) with a side pipe three inches diameter, connected therewith by an opening at the top and bottom; also at the upper end of the side pipe I fixed a valve, so as to slide over and shut the communication with the working barrel, the stem of the valve by which it is regulated, passing through a stuffing box, and by letting a quantity of water return through the side pipe, to the bottom of the working barrel, (the men at the bottom regu-

lating the valve, so that the pump takes the water as it comes,) very little rubbish is then taken into the pump, and much wear and tear of buckets prevented.

Secondly.—I also by this valve and side pipe, preclude the necessity of ever drawing the bucket to displace the air. The clack piece was made as small as possible, and the clack with its gearing very low, in order to have as little space as possible between the bucket and the clack. The clack as represented in the drawing, possesses the advantages of being easily caught by the clack hook, in case of being under water. The ring prevents it from oversetting, and thereby fastening itself in the pumps, and the valves are very easily repaired by unscrewing the cross-bar, which admits of their being taken off and replaced.

Thirdly.—I avoid the inconvenience of suspending the pumps by ropes, by forming the suction-pipe in two pieces, one inner and outer pipe; the outer pipe is bored for about six inches in length, and the inner one turned cylindrically to fit it; they slide into each other, the whole length of a regular pipe, viz. nine feet; and they are made tight by collars of leather, surrounded by a cup filled with water and clay. The pumps are supported at proper distances, so as to suit the length of the pipes, by beams, and across those are other beams upon which the flanches of the pipes rest; these last are not fastened by any bolt, in order that they may be readily removed; the pumps by these means remain stationary, and the suction-pipe lengthens as the pit is sunk, until it is drawn out to its full extent. The whole column is then lowered to the next flanches, and another pipe is added to the top; the lower end of the suction pipe is formed somewhat like a crank, in order that the sinkers, by turning it round upon the other pipe, may move it from one place to another, and so prevent the necessity of sinking immediately under it.

Fourthly.—The pumps being stationary as above stated, the pipe at the top will of course deliver the water at the same level at all times, and instead of being obliged to lengthen the column every yard sunk, it will only be necessary every nine feet.

By sinking the pit above mentioned in the manner I have stated, the whole of the difficulties so generally complained of were obviated, the safety of the workmen employed greatly increased, and much time, labour, and expense saved. If the above should appear to the Society deserving of their notice and patronage, or the publishing of

of it calculated for utility, they will thereby highly gratify and oblige

Their most obedient humble servant,

W. Brunton,
Engineer.

Butterley Iron Works, Derbyshire,
Oct. 20, 1810.

To C. Taylor, M.D. Sec.

Explanation of the Drawings of Mr. William Brunton's *improved Pump, for Mining, and Sinking Shafts.* Plate VIII. fig. 1, 2, 3, 4, 5, 6.

Fig. 1, is a section of a shaft or pit, with the pump fixed in it; it is cast in lengths of nine feet each, screwed together by flanches, and supported by beams extending across the pit, (as shown in the plan, fig. 6,) short pieces are laid across these, with half circular holes in them; these being put round the pump, just beneath a flanch, sustain the pump firmly, but may quickly be removed when it is required to lower the pumps in the pit; and, as they are not fastened, they do not prevent the pumps being drawn upwards; A, fig. 1, is the door which unscrews, to get at the lower valve or clack of the pump; this is more clearly explained in the enlarged section, fig. 2, where A has the same designation. B, fig. 2, is the working barrel, with the bucket D, working in it; E is the clack, also shown enlarged in figs. 3 and 4; F is the suction pipe, and GG, the moveable lengthening piece; this slides over and includes the other, as in fig. 2, when the pump is first fixed; but, as the pit is sunk, it slides down over the pipe F, to reach the bottom, as in fig. 1; the outside of the inner pipe F, is turned true and smooth, and the inside of the outer pipe G, at the upper end, is bored out to fit it; the junction is made perfect by leathers placed in the bottom of the cup, *a a*, which holds water and wet clay over them, to keep them wet and pliable, and consequently air-tight; the lower extremity of the suction pipe G, terminates in a nose, pierced with a number of small holes, that it may not take up the dirt; this nose is not placed in a line with the pipe, but curved to one side of it, so as to describe a circle when turned round; by this means the sinkers can always place the nose in the deepest part of the pit, as shown in fig. 1; and when they dig or blast a deeper part, they turn the nose about into it, the sliding tube lengthening down to reach the bottom of it; by this means there is never a necessity to set a shot for blasting so near the pump foot, as to put it in any dan-

 ger

ger of being injured by the explosion, as is the case in the common pump; in which this danger can only be avoided by moving the pump foot to one side of the pit, which necessarily throws the whole column of pumps out of the perpendicular.

The construction of the clack is explained by figs. 3 and 4, the former being a section, and the latter a plan; LL is a cast-iron ring, fitting into a conical seat in the bottom of the chamber of the pump, as shown in fig. 2; it has two stems *l l* rising from it, to support a second iron ring MM; just beneath this, a bar *m* extends across from one stem to another, and has two screws tapped through it; these press down a second cross-bar *n*, which presses the leather of the valves down upon the cross-bar of the ring L, and this holds it fast, forming the hinge on which the double valves open, without the necessity of making any holes through the leather as in common; but the chief advantage is, that by this means the clack can be repaired, and a new leather put-in in far less time than at present, an object of the greatest importance; for, in many situations, the water gathers so fast in the pit, that if the clack fails and cannot be quickly repaired, the water rises above the clack-door, so as to prevent any access to it, and there is no remedy in the common pump but drawing up the whole pile of pumps, which is a most tedious and expensive operation. In Mr. Brunton's pump, the clack can at any time be drawn out of the pump, by first drawing out the bucket, and letting down an iron prong, fig. 5, which has hooks on the outsides of its two points; this when dropped down will fall into the ring M, and its prongs springing out, will catch the underside and hold it fast enough to draw it up. Another part of Mr. Brunton's improvement consists in the addition of a pipe H, fig. 2, which is cast at the same time with the barrel, and communicates with it both at the top and at the bottom, just above the clack; at the upper end the pipe is covered by a flat sliding plate, which can be moved by a small rod *b*, passing through a collar of leather; the rod has a communication by a lever, so that the valve can be opened or shut, by the men in the bottom of the pit; the object of this side pipe is, to let down such a proportion of the water which the pump draws, as will prevent the pump drawing air; though of course the motion of the engine will be so adapted, as not to require a great proportion of the water to be thus returned through the side pipe; yet it will not be possible to work the engine so correctly, as not to draw some air without this contrivance; and if it does,

it

it draws up much dirt and pieces of stone into the pump, besides causing the engine to work very irregularly, in consequence of partially loosing its load every time the air enters the pump. Another use of the side pipe is, to let down water into the chamber of the clack to fill it, when the engine is first set to work, after the pumps have been standing still, and the lower part of the barrel and chamber empty.

LIII. *Further Remarks on a Case of Injury of the Brain.*

To Mr. Tilloch.

Sir, In the 166th number and 117th page of your valuable Magazine, you did me the honour to insert some notes of a case of an affection of the brain, the consequence of local injury to the head, that came under my care, in which I particularly mentioned the symptoms, the treatment, and the favourable state in which the patient James Thomas was at the time I wrote and sent it you. A very short time after that he had a relapse quite as severe as the former; and as the former was published, I thought it right that the latter should be published also as a supplement to it, and for this reason I have laid it before you.

James Thomas continued to get better and to recover very rapidly, until the 22d of February, when, without any apparent cause, he was taken so ill as to oblige him to retire to bed. He sent to desire I would see him. I did so; and when I got to the house, I found him remarkably weak, so that he could scarcely move himself in any direction, but no part of his body was paralysed: he spoke with difficulty, and articulated very badly, so much so, that I could not understand much of what he said: he lay moaning in the bed, and took, or at least seemed to take, very little notice of any thing or any body. If I asked him a question, he would answer as well as he was able: the only symptom he complained of was a dull pain all over the head; he never pointed to any particular spot, but would shake his head and move his hand over the whole: the pupils of the eyes were dilated, but very readily contracted on the application of a lighted candle. He ate little or nothing; could obtain no sleep; was very watchful. He would remain a whole day without asking for any thing, or speaking to any one. He is amazingly dull and stupid; and his wife tells me, his bowels are confined and his stools

 very

very black; his skin feels hot and dry, and his tongue is furred.

Now, as he got so much better in his former illness, I was induced to resume the same plan of treatment, which was to endeavour to regulate the functions of the skin and of the alimentary canal, and with that view I ordered him to take the following powder immediately:

℞ Hydrargyri Submuriatis gr. vi.
Pulveris Antimonialis gr. ij. Misce.

Feb. 23. The powder has produced some evacuations which are quite black, and smell very offensive. I asked him how he did; he shook his head and answered, Very bad. He still keeps perpetually moaning; he is very thirsty, and his skin is still hot and dry.

℞ Hydrargyri Submuriatis gr. j.
Pulveris Antimonialis gr. ij.
Nitratis Potassæ gr. x. Misce. Fiat pulvis quartis horis sumendus ex Melle.

His drink to be toast and water.

Feb. 24. His bowels keep regularly open, but the fæces are black; his urine is small in quantity, high-coloured, and, as he terms it, very hot; his pulse beats moderately firm, but by no means strong, or very full, but is quite regular; his face is pale, and there is no appearance like congestion about his head. The symptoms do not appear to be in the least mitigated.

The powders to be continued three times a day.

Feb. 28. His mouth feels sore from the use of the mercury; the secretion of saliva is considerably increased, and he voids more urine; the skin feels moist, and is bedewed with a gentle perspiration. His evacuations are not so black, and bowels are regular; but his eyes are for the first time inflamed, and the light feels troublesome, and when suddenly placed before his eyes produces pain. He can take a little gruel, but as yet cannot sleep; he is very drowsy and eager to sleep, but something he knows not what prevents him.

The powders to be discontinued, and the following mixture to be taken:

℞ Liquoris Ammoniæ Acetatis ℥ij.
Misturæ Camphoræ ℥vß.
Syrupi Croci ℥ß. Misce. Cochlearia duo ampla quartis vel sextis horis sumat.

March 3. The inflammation of the eyes is quite subsided, and the light can be admitted without producing pain or inconvenience; he now begins to speak spontaneously;

ously; he slept several hours last night, and that sleep was sound and undisturbed, and he appears to be much refreshed; he is able to sit up in bed for an hour at a time, and takes broth and small quantities of the whiter kinds of meat, but he is very much reduced in bulk and in strength; his bowels keep regularly open, and the colour of the fæces greatly improves. I ordered him to go on with the mixture as before.

March 7. He continues gradually to get better; for the last three days he has sat up three hours at a time without being much tired; his appetite increases, and he is in every other respect proportionally well. The pain in his head has almost left him; his speech is still very indistinct, and in speaking he very often forgets what he was going to say. At times he seems to lose all recollection for a moment. The mixture continued.

March 20. His fæces are now perfectly of a natural colour, and he goes to stool once or twice every day. His skin keeps moist; his appetite is very good; he is still in a state of great debility; he has left off taking his medicine; talks better; pains in the head quite gone; is able to walk out a short distance; his memory is as good as usual, and he is mending hourly.

May 12. I have just called and found him with his wife at dinner, and apparently eating very heartily; he is got quite fat since last I saw him; he tells me he can pursue the office of constable as he was accustomed, and feels as well as ever he did in his life, except his articulation, which is the only thing from which he suffers.

From the peculiar and well marked symptoms under which the patient has laboured in both attacks, I think little doubt can remain as to the cause which produced them; namely, that it was pressure on some part of the brain; but on what part that pressure was, or what caused the pressure, scarcely admits of a conjecture, for the pain has never been confined to any particular part; but, on the contrary, was generally diffused over the whole head. The mode of treatment has been very simple, and the three chief points it had in view, were to regulate the evacuations of the alimentary canal, to set right the morbid secretion of bile, and to keep up a gentle action or perspiration on the skin. Now this treatment, as the relation of the case shows, has been attended with success; for as soon as the skin became in a natural state, and the excretions from the bowels regular and of a good colour, so soon did the symptoms begin to be mitigated, and continued so to do till they disappeared.

peared. Some may say, that in the present instance the deranged state of the skin and of the bowels was the effect of the disease, and that the treatment adopted removed the effect without first removing the cause: but this case (as well as many others) clearly proves to me the importance and great necessity of paying strict attention to the state of the skin, and of the alimentary canal, in *every disease.*

I am, with all due respect,
Your humble servant,
Hatton Garden, May 16, 1812. JOHN BURNE.

LIV. *A Method of correcting the Variation of the Mariner's Compass. By Mr.* JOHN HODGSON, *Charles Street, St. James's Square*.*

SIR, I TAKE the liberty of requesting you to submit to the Society for the Encouragement of Arts, Manufactures and Commerce, a small theodolite, to which an addition has been made, calculated, it is hoped, to be of some utility.

The frequent recurrence to the variation of the compass, which is necessary in the use of the theodolite, is always attended with trouble, and not unfrequently productive of error.

It appears to me, that by a very simple expedient these inconveniences may in a great measure be removed. To the magnetic needle of the instrument, let one of brass be affixed moveable upon the centre of the former; the brass needle may be termed the corrector. Nothing more is necessary than to place the magnetic needle and the corrector, at the angle of the variation, in such a manner that, the former being in the magnetic meridian, the latter shall be in the true meridian. The south end of the corrector will point to the true bearing of an object seen through the sights of the theodolite.

I also beg to lay before the committee a ship's compass, in which will be found a different application of the same principle. In this instrument, the needle is made moveable under the compass card, so as to be placed by the officer of the watch, or any other proper person, under the variation line, as often as an azimuth or an amplitude shall have been taken. The points of the compass will, by these means,

* From *Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce,* for 1811.——The silver medal of the Society was voted to Mr. Hodgson for this communication.

means, be directed to their corresponding points in the heavens, and the mariner will know that he is really sailing upon the rhumb indicated by the cord.

I am inclined to think that a seaman may sometimes be liable to error, in the continual reference which it is necessary for him to make to the variation of the compass, from a possibility of his allowing it on the wrong side, by subtracting where he should add, or by adding where he should subtract it: even under a supposition that such a mistake is not likely to occur, the use of this instrument as an additional check, in a matter of so much importance as is the ascertaining of a ship's course, may not be entirely unworthy of attention.

It is very probable, that from my imperfect information upon these subjects, I am now proposing what has before been suggested, and been found either to be wholly impracticable, or of little or no utility when reduced to practice. This is indeed the more probable from the extreme simplicity of the expedient itself, which could scarcely have escaped the attention of the many enlightened seamen, and others, who have devoted their minds to subjects of this nature. This consideration, however, is not sufficient to induce me to lose a chance of suggesting any the most trifling hint which may be useful to a class of men to whom we are so much indebted.

It may be objected against the application of this principle to a ship's compass, that as the variation in a long voyage is continually changing, the card in a short time after it has been adjusted will not point truly. This must be admitted; but it must also be recollected that it will agree with the last variation ascertained, and which is that on which the mariner must rely, until a fresh observation shall have been taken.

It may also be objected, that through the negligence of the persons employed to regulate this instrument, errors may arise, equal to those which it is intended to obviate; but surely, whatever may tend to afford a correct knowledge of a ship's course, is of sufficient importance to render the adjustment of the card an office by no means unworthy of the captain himself; and it cannot be supposed that he, or indeed any other officer, can be liable to error in an operation merely manual.

If we admit, however, that these objections are well founded, an instrument of this description might not be destitute of utility, placed in the captain's cabin, or some other convenient part of the ship, where it might continually

ally indicate her course, without the necessity of a reference to the last observation; and at the same time serve as a check upon the several courses entered from the steering-compass.

Whatever obstacles may exist to the application of this contrivance to the ship's compass, I apprehend that there will be none to its utility, as applied to the instruments used in land surveying; confined as that business is to tracts of country within which only a trifling annual variation takes place, and to which variation the corrector may be set whenever it becomes considerable.

To the common boat- and pocket-compass the same principle may be applied with equal utility; to the latter especially, which may frequently, perhaps, be in the hands of persons unacquainted with either the bearing or amount of the variation of the magnetic needle.

As the instruments submitted to the Committee are merely intended for illustration, I have not aimed at great nicety in their mechanism. It is obvious that they are capable of considerable improvement, and that both the theodolite and the ship's compass may be so constructed as to be capable of all requisite accuracy in their adjustment, without loading them in such a manner as to obstruct the free motion of the needle.

If a modification of these instruments, in itself so simple, shall be found to be of the least utility, I shall feel highly gratified.

I am, sir,

Your very obedient servant,

JOHN HODGSON.

Charles Street, St. James's Square,
April 23, 1811.

To C. Taylor, M.D. Sec.

Reference to the Drawing of Mr. JOHN HODGSON'S *Variation Compass.* Plate IX. fig. 1 and 2.

The two figures in this plate are, a plan and perspective view of a small theodolite or circumferentor, for taking horizontal angles by the magnetic needle; it is to the latter alone that Mr. Hodgson's improvement applies; being a brass needle *a*, fig. 1, which is fitted upon the brass centre-piece, or cap, of the real needle *b*, in such a manner that it can be easily turned round to make any angle with the needle, and having sufficient friction to remain where it is placed; both needles are poised on the same centre-point, with an agate cap in the usual manner, the brass needle being

being only an index to point out the divisions on the circle within the compass: this index being set so as to make the same angle with the needle, as the difference of the true and magnetic meridians, will at all times give the true bearings of any object observed through the two sights *e* and *f*, which are diametrically opposite, and at the zero of the divided circle; at least whilst the variation of the needle continues the same; but as this alters by the instrument being used in a different tract of country, the brass index *a* must be turned round a corresponding number of degrees, which are shown by the divided circle in the box. The remaining parts, shown in fig. 2, are AA, the upper ends of the tripod supporting the instrument; B the ball and socket by which the box is adjusted, so as to be horizontal; the stem of the ball has a circle *c* fixed to it, carrying two sights *g h*, through which the observations are taken; the circle *c* is divided into degrees, and the compass-box, which turns round upon it, has a vernier applying to them: this renders the instrument a theodolite, as any two objects may be observed through the sights *e f*, and *g h*, and the divisions on the circle *c* will denote the angle between them, and at the same time the bearing of any object may be taken by observing it through the sights *e f*, and noting the degree pointed out by the brass needle *a*, which is the true bearing required, without any allowance for the variation, as was the case in the common instrument.

LV. *On the Rev. Mr.* LISTON'S EUHARMONIC ORGAN, *and his "Essay on perfect Intonation," just published, for explaining fully the Principles of Tuning, and of performing upon this Organ with perfect Harmonies, in almost every possible Variety of Keys and Passages. By Mr.* JOHN FAREY *Sen.*

To Mr. Tilloch.

SIR, THE work which has for near a year past, been anxiously expected by great numbers, for explaining the principles and practice of *a Musical Scale, without any temperament or imperfections in its harmony*, has at length appeared and is to be had of Messrs. Longman and Rees, or any other Bookseller, or at the Music-sellers, and I take the earliest opportunity, of mentioning a few particulars therefrom, in addition to what I communicated in your

37th

37th volume, page 273 *; after a perusal of the Rev. Mr. Henry Liston's Manuscript, with which he favoured me last summer. Since the period alluded to, Mr. *William Shield*, Mr. *Thomas Greatorex*, Mr. *J. Davy*, Mr. *Samuel Westley*, and a great number of other eminent musicians have examined and fully tried the Organ, with 20 pipes in each octave, (through three stops) yielding 60 sounds in each octave, which was exhibited last summer at Messrs. Flight and Robson's, in St. Martin's Lane, and the four professors above mentioned, since voluntarily transmitted to Mr. L. very ample testimonials of the practicability and great value of his improvements on the scale of Keyed Instruments, and which are inserted in his preface.

The interval between the several Minor & Major consonances $\left\{\begin{matrix}\flat D \;\&\; D,\ F \;\&\; {*}F,\ \flat G \;\&\; G,\ \flat B \;\&\; B, \text{ and } \flat C \;\&\; c \\ \text{or 2d \& II, 4th \& IV, 5th \& V, 7th \& VII, \& 8th \& VIII}\end{matrix}\right\}$, Mr. L. denominates a *Limma*, (page 8) its value in each of the above cases being T—H, or $f + 2\epsilon + 2\Sigma$, or $47\Sigma + f + 4m$, or the Semitone medius † of M. Overend, whose nomenclature I have always followed and wished to recommend others to adopt, for the sake of uniformity and precision in treating on the Scale. The Interval between $\left\{\begin{matrix}\flat E \;\&\; E, \text{ and } \flat A \;\&\; A \\ \text{or 3rd \& III, and 6th \& VI}\end{matrix}\right\}$, Mr. L. calls a *Grave Limma*, (p. 8) being $t - H$, or $f + \epsilon + \Sigma$, or $36\Sigma + f + 3m$, and is the Semitone minor of Overend, &c.

The Interval between $\left\{\begin{matrix}{*}D \;\&\; \flat E,\ E \;\&\; \flat F,\ {*}G \;\&\; \flat A, \text{ and } {*}B \;\&\; c \\ \text{or *II \& 3rd, III \& b4th, *V \& 6th, \& *VII \& VIII}\end{matrix}\right\}$, Mr. L. calls a *Diesis* (p. 10), being $2H - t$, or $2\epsilon + \Sigma$, or $21\Sigma + 2m$, and is the Enharmonic Diesis.

The Interval between $\left\{\begin{matrix}{*}C \;\&\; \flat D,\ {*}E \;\&\; F,\ {*}F \;\&\; \flat G,\ {*}A \;\&\; \flat B, \text{ and } B \;\&\; \flat C \\ \text{or *I \& 2nd, *III \& 4th, IV \& 5th, *VII \& 7th, \& VIII \& 8th}\end{matrix}\right\}$, Mr. L. calls a *Grave Diesis* (p. 10), being $2H - T$, or ϵ or $10\Sigma + m$, and is the Minor Comma.

The Interval between $\left\{\begin{matrix}\flat F \;\&\; {*}E, \;\&\; \flat C \;\&\; {*}B \\ \text{or b4th \& *III, \& 8th \& *VII}\end{matrix}\right\}$, being $T + t - 3H$, or $f + \Sigma$, or $26\Sigma + f + 2m$, is not particularly named by Mr. L. that I observe; it is the Chromatic Diesis of Dr. Callcott, and its ratio is $\frac{16384}{16875}$.

* The specification and description, with a plate, of Mr. L.'s Patent Organ, appeared in our xxxviith vol. p. 328, and vol. xxxviii. p. 47.—EDITOR.

† Not the Semitone *Minor*, or *Limma*, of my engraved Table of Intervals, vol. xxviii. Plate V.

In

In like manner as the *Minor* and *Major* Intervals of the Scale are at two unequal distances or intervals apart, as mentioned above, the Sharpen'd Notes of Mr. L.'s Scale are also at two different distances from their naturals*, in different parts of the Scale, and so have flats two different effects, on different notes, respectively: thus,

1st. The Interval between

$$\left\{\begin{array}{l} *C \;\&\; **C, D \;\&\; *D, *F \;\&\; **F, G \;\&\; *G, \text{ and } B \;\&\; *B \\ \text{or } *I \;\&\; **I, II \;\&\; *II, IV \;\&\; *IV, V \;\&\; *V, \;\&\; VII \;\&\; *VI \end{array}\right\},$$

is $t - H$, or $\mathfrak{f} + \epsilon + \Sigma$, or $36\Sigma + f + 3m$, the Semitone minor; and 2nd, between

$$\left\{\begin{array}{l} C \;\&\; *C, E \;\&\; *E, \text{ and } A \;\&\; *A \\ \text{or } I \;\&\; *I, III \;\&\; *III, \;\&\; VI \;\&\; *VI \end{array}\right\}, \text{ is } T - H, \text{ or } \mathfrak{f} +$$

$2\epsilon + 2\Sigma$, or $47\Sigma + f + 4m$, the Semitone medius, both of which kind of sharps, being on *major* Intervals, are called *Redundant* Intervals by Mr. L., and the word major is omitted, as Redundant Second, Redundant Fourth, &c.

3rd. The Interval between

$$\left\{\begin{array}{l} \flat D \;\&\; \flat\flat D\dagger, F \;\&\; \flat F, \flat G \;\&\; \flat\flat G\dagger, \flat B \;\&\; \flat\flat B, \;\&\; C\flat \;\&\; \flat\flat C\dagger \\ \text{or 2nd } \&\; \flat 2, \text{ 4th } \&\; \flat 4, \text{ 5th } \&\; \flat 5, \text{ 7th } \&\; \flat 7, \;\&\; \text{8th } \&\; \flat 8 \end{array}\right\},$$

is $t - H$, the Semitone minor; and 4th, between

$$\left\{\begin{array}{l} \flat E \;\&\; \flat\flat E\dagger, \;\&\; \flat A \;\&\; \flat\flat A\dagger \\ \text{or 3rd } \&\; \flat 3, \;\&\; \text{6th } \&\; \flat 6 \end{array}\right\}, \text{ is } T - H, \text{ the Semitone}$$

medius, both of which kind of flats, being on *minor* Intervals, are called *Diminished* Intervals, and the word minor is omitted by Mr. L. in naming such, as Diminished Second, Diminished Fourth, &c.

I must reserve a further account of this interesting volume for another communication, only mentioning, that Messrs. Flights have very nearly finished a new Organ on Mr. Liston's construction, with ♭F and other additional Notes, so as considerably to extend the Scale, and perfect more Keys, than on the Organ made in Scotland, which Mr. Liston exhibited last year, and which is still open daily for the inspection and hearing of the lovers of Harmony, who will not neglect, I hope, to treat themselves with examina-

* In all regularly *Tempered Scales*, there is but one value to *Sharps*, and the same is also the value of the *flats*, throughout the scale, and it is called Minor Limma (l); between these and the next adjoining notes are Major Limmas (L); and every regular Douzeave is composed of $7T + 5l$ in each octave, in an invariable order.

† *B, &c, or *VII and VIII, *F and **F or IV and *IV, &c. do not readily appear to be agreeable to Mr. L.'s principle of naming the Intervals, on which account I have stated these intervals as above C, although ♭♭D, ♭♭G, ♭♭C, ♭♭E and ♭♭A are not in his Scale. It is observable, that in double Sharps and double Flats, one of such is $t - H$ and the other $T - H$, so that the value of each ♭♭ is the same, viz. the Redundant Limma of Mr. Liston, $= T + t - 2H$, $= 2\mathfrak{f} + 3\epsilon + 3\Sigma$, or $83\Sigma + 2f + 7m$.

tions

tions of these very curious and Unique Instruments; and hoping, that Mr. L. may receive ample remuneration for his ingenuity and labours, in the Sale of his Work and his Organs.

I remain sir,

Your obedient servant,

JOHN FAREY Sen.

12, Upper Crown Street, Westminster,
16th May, 1812.

LVI. *Notice respecting the Geological Structure of the Vicinity of Dublin; with an Account of some rare Minerals found in Ireland. By* WILLIAM FITTON, *M. D. Communicated by* L. HORNER, *Esq. Secretary to the Geological Society.*

[Continued from p. 311.]

THE following substances, with the exception of the last two, have been found within the district to which the preceding observations relate.

1. *Vesuvian*—(*Idocrase*, Haüy.) This mineral was observed by Mr. Stephens, in specimens found by me at Kilranelagh in the county of Wicklow; where it occurs in irregular crystalline masses, in a rock composed of common garnet of a reddish brown colour, of quartz, for the most part greenish, apparently from the admixture of a lamellar fossil of that hue, and a small quantity of yellowish white felspar. The dodecahedral figure of the garnet was very distinct in several of these specimens; but the form of the Vesuvian was not so well exhibited, some indistinct prisms only being observable; and in general, the crystalline shoots of the latter mineral had assumed a diverging or stelliform arrangement, an appearance which I have not observed in specimens of this substance from other places; but their easy fusibility, lustre, colour, and other characters, were sufficiently decisive of their nature.

I could not discover the original situation of the compound above mentioned at Kilranelagh; but the size, the great weight, and angular form of the blocks consisting of it, render it probable that they were not far removed from their natural place: and the country in that neighbourhood is composed of primitive substances, among which *Garnet* rock is described by mineralogists, as constituting beds.

It is remarkable, that a compound much resembling that which I have now described, occurs also in the county of Donegal; from whence specimens in the cabinet of the Dublin Society, and that of Dublin College (No. 30), were obtained.

obtained. The garnet and vesuvian in these specimens are scarcely to be distinguished from those of Kilranelagh; and, as at that place, are accompanied by quartz, often of a similar greenish colour; with the addition however of blueish grey granular limestone, and of a fibrous substance, not improbably tremolite mixed with carbonate of lime. I have not seen any felspar in the specimens from Donegal *.

2. *Grenatite*—(*Staurotide*, Haüy). This mineral was detected by Mr. Stephens in a micaceous compound of which I found a specimen at the *Glenmalur* lead mines, in the county of Wicklow: and I have reason to suppose, that it is not very uncommon in the schistose rocks along the south-eastern confines of the granite in that county. The crystals from Glenmalur were small; but their colour, form, and characteristic crossing, were very distinct, and they were infusible before the blowpipe.

3. *Beryl*—(a variety of *Emerald*, Haüy).—This was found by Mr. Stephens and myself, imbedded in granite, near Lough Bray, in the county of Wicklow. (Museum of Dublin College, No. 39.) Mr. Weaver has discovered it in blocks of granite, near Cronebane in the same county; and I have obtained specimens, probably belonging to the same species, in the Dublin mountains, above *Dundrum*.

4. *Andalusite*—(*Feldspath-apyre*, Haüy). This mineral has been found by Mr. Stephens and myself, in very distinct specimens, on the north-east side of *Douce*-mountain, in the county of Wicklow; apparently imbedded in the mica-slate of which that mountain is composed, and accompanied by quartz, mica, and a remarkable substance hereafter to be mentioned. It differs from the Andalusite of Spain and of Scotland, chiefly in possessing an inferior degree of hardness; for although some specimens readily scratch glass, others yield easily to the knife: but the Count de Bournon has observed an equal variation in the hardness of specimens of this substance obtained by himself at Forez †;-and I have found that of the Scottish stone to vary very considerably.

This mineral seems to have been first taken notice of, under the name of *Würflicher-* (cubic) *Feldspath*, by Karsten ‡; who took his description from specimens in the Leskean cabinet, now in the possession of the Dublin Society (No. 907-b, &c.): and by a comparison of these with

* This compound from Donegal has been described by Mr. Sowerby; British Mineralogy, August 1810, p. 133.

† *Journal de Physique*, xxxiv. (1789), p. 453.

‡ Bergmannisches Journal, vol. ii. (1788), p. 809.

some of the specimens above mentioned from Douce, I have ascertained the identity of Karsten's mineral with Andalusite. I have not found however, that his claim to the first detection of this species has been mentioned by subsequent writers; although his opinion with respect to its affinity with felspar, accords with that which Haüy is disposed from his latest observations to adopt: *Tableau comparatif*, &c. p. 217.

To the Andalusite is also to be referred, a mineral which occurs in great abundance at Killiney in the county of Dublin, first observed there by Dr. Blake, and for some time considered as belonging to a species not described by mineralogists: the schist at the southern extremity of the *Scalp*, appears to contain the same substance, as well as that next to be described; and it is found also near the head of Glenmacanass. It is most remarkable on the shore at *Killiney*, at the southern extremity of the cliff under the obelisk hill, where it abounds on the surface of the mica-slate, and also imbedded in the rock. In a recent fracture, it is imperfectly distinguishable from the mass of the stone; but as it resists decomposition better than the other substances of which the aggregate is composed, it appears very distinctly on the surfaces which have been long exposed to the weather.

The *Andalusite* when thus brought to view, appears generally in the form of embossed groups, consisting of slender prismatic crystalline shoots, of a dull greyish black colour, which are sometimes assembled in a stellated form, but more frequently without any determinate arrangement: these are commonly rounded at the edges from the effects of decomposition, and in that case, several of their principal characters are scarcely to be distinguished; but in the pieces least affected by exposure, when attentively examined, the crystalline form, colour, lustre, cleavage, and other characters of this species, are sufficiently distinct.

5. The andalusite of Douce-mountain is accompanied, as has been mentioned, by another mineral besides quartz and mica; the characters of which have much affinity to those of the *indurated talc* of Werner, and which is placed under that denomination in the collection of Dublin College (Nos. 495—6—7): a specimen of the same kind, stated to be from *Glendalogh*, in the county of Wicklow, was found also in that collection (No. 404); and a similar substance was observed by, Mr. Stephens at the southern extremity of the Scalp.

The following are some of the characters exhibited by the

the specimens from Douce, to which I have access at present; these specimens however are not very distinct, and I give this imperfect description, only with a view to point out this substance as deserving of further examination.—

Its colour is yellowish grey, approaching in various degrees to yellowish white: it is translucent in about the same degree as wax.

The form under which it has principally occurred, is that of four-sided prisms, nearly square, the length of which is in some instances more than thrice their breadth, without any visible acumination. The surfaces of these prisms are uneven, and their angles ill defined.

The fracture, transversely to the axis of the prisms is irregularly curved-foliated, and splintery; exhibiting numerous scaly distinct concretions sometimes radiating from the centre, the lustre of which is splendent and pearly. In the direction of the axis, the fracture seems to be uneven passing into splintery.

It is scratched by calcareous spar, and easily cut by the knife; with a strong pressure it leaves a whitish trace on glass, which it sometimes scratches, apparently by the action of some harder particles dispersed through it.

The specific gravity of some of the purest pieces that I could select was 2·888.

Before the blowpipe this substance appears to swell a little, from the separation of its folia, on the first application of the heat; it becomes white, opake, and brittle, and in small fragments gives, with some difficulty, a solid white enamel.

In the specimens from Douce-mountain, the connection of the mineral now described with andalusite, is very remarkable; several of the prisms, which on the outer part consist of the talc-like matter, containing within a nucleus of andalusite, that in some instances fills nearly the whole of the interior of the prism, but in others forms little more than an axis, of an irregular figure and with rounded edges, from which the folia of the investing matter appear to radiate. The nature of the connection between these substances is still obscure; but the occurrence of talc in genuine crystals of the figure above mentioned, has not hitherto been stated on any good authority; and it is not altogether improbable, that the prismatic form assumed by the substance now under consideration, may really be that of andalusite; the latter mineral having been wholly or partially removed, and the talc-like matter moulded in its place.

6. *Hol-*

6. *Hollowspar*, Jameson—(*Macle*, Haüy). Very distinct specimens of this mineral have been found by Mr. Davy at Aghavanagh in the county of Wicklow; and I have observed it at Baltinglass-hill, within a few miles of that place.

From some passages among the papers of Mr. Stephens, it appears that he had found reason to suppose that there existed a connection between the species *andalusite* and *macle;* although the specimens which he had seen, were not such as to enable him to decide on the precise nature of their relation to each other. The appearances of several specimens of the latter mineral, which I have lately had an opportunity of examining, tend to confirm this opinion; and even induce me to suspect that the crystalline part of that curious substance, is in reality the same with andalusite. In one of these especially, a very fine specimen of macle from Britanny in the possession of Mr. L. Horner, that part of the complex crystal, which is usually of a whitish or yellowish hue, has in several places the reddish colour, as well as the lamellar fracture, lustre, and other characters of andalusite; and like that substance also, is infusible before the blowpipe, becoming white and nearly opake: and it is further remarkable, that in this specimen, as in those already mentioned from Douce-mountain, the crystalline matter is in some places invested with a coating of a talc-like substance: which is the case likewise, although less distinctly, with several of the specimens of andalusite that I have seen, from other countries.

The following substances have been found at places not included within the district, to which the preceding part of this paper relates: but they may perhaps be subjoined without impropriety, as they have hitherto been rare, and are in other respects deserving of notice.

7. *Pitchstone.* This mineral has been found in a vein traversing granite, in the vicinity of Newry, in the county of Down; where it presents the following characters, for part of the description of which, I am indebted to Mr. Jameson of Edinburgh:—

Its colour is intermediate between mountain and leek green.

It is massive.

Fracture small and not very perfect conchoidal:

Internal lustre vitreous, and shining.

It exhibits lamellar distinct concretions: the plates being from

from about one-fourth to one-tenth of an inch in thickness, and further divisible into pieces of a rhomboidal form, of various angles.

The surface of the concretions is smooth, and strongly glistening.

The mineral, in fragments, is slightly translucent on the edges:

It scratches glass, but is easily scratched by quartz:

It is easily broken:

Specific gravity 2·29.

Before the blowpipe without addition it yields a greyish-white frothy enamel.

It is in some places porphyritic; containing imbedded minute crystals of felspar and of quartz.

A letter from a very intelligent observer, who has examined this substance in its native place, states the following particulars respecting its position and geological relations; viz. "The vein is first observable in the Townland of Newry, at the bottom of a bank of granite, about half a mile from the northern end of the town, on the right of the road leading to Downpatrick: it crosses the road, and runs due westward, ending on the side of the great road from Newry to Belfast. Its length, so far as hitherto observed, is half a mile."

"The rock, which is covered with mould to the depth of about a foot, consists of grey granite: the vein is about two feet and a half, or two and a quarter in width; at the places of contact both the granite and pitchstone are disintegrated, the latter being almost as soft as clay, but becoming gradually harder as it approaches the centre of the vein. The structure of the vein is foliated, the folia being perpendicular to the horizon, and also to the walls; and besides these, there are seams that run longitudinally, parallel to the horizon, and nearly perpendicular to the folia."

Although the substance above described presents some peculiarity, in being divisible into rhomboidal fragments, it approaches in this respect to the pitchstone of Arran "in lamellar concretions;" a variety considered by Mr. Jameson as having hitherto occurred only in that island *, and which holds, as it were, a middle place, between the mineral from Newry and that possessing the more common characters. The occurrence of pitchstone in geological circumstances like those above mentioned, has hitherto been very rare; but Mr. Jameson has described a vein of

* Jameson's Mineralogy, vol. i. p. 261.

it which traverses granite, observed by himself in the island of Arran *.

8. *Wavellite.* This remarkable mineral has recently been found in the county of *Cork*, at *Springhill*, near *Tracton-abbey*, about ten miles south-eastward from the city. The Rev. Mr. Hincks, of the Cork Institution, who has been so kind as to send me some specimens of it from that place, informs me that it was found very near the surface, in digging the foundation of a cottage, in the neighbourhood of a hill composed of *flinty-slate;* and that he has seen it adhering to a fragment of rock of that description: but it has occurred principally detached in the soil, in the form of spherical nodules irregularly grouped together, and of various sizes, the largest being about three-fourths of an inch in diameter. These nodules are coated externally with a yellowish-brown earthy crust, and within are of a crystalline structure; resembling in their appearance and properties the original *Wavellite* from Devonshire, described by Mr. Davy, from which indeed, some of the specimens from the county of Cork can scarcely be distinguished.

The most distinct and purest specimens of this mineral from the last mentioned place, that I have seen, exhibit the following characters, viz.—

The globules are formed of crystalline spiculæ radiating from a common centre; but the surfaces of these are seldom perfectly plane, and their figure when separated is not distinctly to be discerned. The exterior of the nodules, is composed of the terminations of the crystalline shoots, which are dihedral and obtuse-angled; the curvature of their surfaces, however, did not admit of their being accurately measured.

The spiculæ are nearly transparent and without colour, or of a very light shade of yellowish green. The lustre of their surface is strongly splendent, and glassy, inclining to that of silk:

The cross fracture of the spiculæ seems to be flat conchoidal, with a splendent lustre.

This substance scratches glass; but it is so easily broken down as to render difficult the trial of its hardness.

The nodules are very easily divided in the direction of the rays: the spiculæ are extremely brittle.

The specific gravity of a portion, which was very pure, and about twenty grains in weight, was 2·34.

* Mineralogy of Scottish Isles, 4to, i. p. 81.

Before

Before the blow-pipe the spiculæ of this substance are separated from each other, becoming white, opake, and friable, without any mark of fusion. The flame by passing over it acquires a slight tinge of green.

The nodules above mentioned are not unfrequently decomposed throughout; having lost their internal lustre and hardness, and acquired a dull grey or brownish colour. They sometimes, when in this state, contain numerous small spongy cavities; and in some instances have been found reduced altogether to the state of clay, apparently from the effects of decomposition.

It would appear that the fluoric acid, of which Mr. Davy has ascertained the presence in the Wavellite from Devonshire, exists also in that from Cork; for glass is corroded, by heating upon it, in a drop of sulphuric acid, a fragment of the mineral from either of those places.

LVII. *A new Solution of two Fluxions proposed by* Simpson. *By* James Andrew, *LL.D.*

To Mr. Tilloch.

Sir, In Simpson's Fluxions, pages 100 and 101, of 2d edition, there are two fluxions proposed, whose fluents are to be found, viz. 1st, $\frac{\dot{y}\sqrt{g^2+y^2}}{y^6}$; and 2dly, $\overline{a-fz^n}|^{\frac{1}{2}} \times z^{-\frac{7}{2}n-1}\dot{z}$, and these fluents are determined in the places referred to by means of rules investigated in pages 95 and 98 of the same work. The fluent in the former example being $\frac{\overline{g^2+y^2}|^{\frac{3}{2}} \times \overline{2y^2-3g^2}}{15g^4y^5}$, and in the latter case, $-\frac{\overline{a-fz^n}|^{\frac{3}{2}} \times (30a^2+24fz^n+16f^2z^{2n})}{105na^3z^{\frac{7}{2}n}}$.

As I never much relished the rules in question, as they have a tendency to confound beginners, and are neither useful nor necessary in the place where they have been introduced, I trust the two following new solutions will not prove unacceptable to some of the readers of your valuable Magazine, as being more practicable in general, and more easily understood, than the methods and rules referred to. I am, sir, your most obedient servant,

Addiscombe Place, 23d May 1812. James Andrew, LL.D.

1. Given

1. Given the fluxion $\frac{\dot{y}\sqrt{g^2+y^2}}{y^6}$, or $\overline{g^2+y^2}\big|^{\frac{1}{2}} \times y^{-6}\dot{y}$, to find its fluent.

Here $\overline{g^2+y^2}\big|^{\frac{1}{2}} \times y^{-6}\dot{y} = \overline{g^2+y^2}\big|^{\frac{1}{2}} y^{-5} y^{-1}\dot{y} =$ $\overline{g^2 y^{-2}+1}\big|^{\frac{1}{2}} y^{-5}\dot{y}$.

Put $g^2 y^{-2}+1 = z$:

then $y^{-2} = \frac{z-1}{g^2}$;

and $y^{-4} = \frac{\overline{z-1}\big|^2}{g^4}$:

and $-4y^{-5}\dot{y} = \frac{2\dot{z}\times\overline{z-1}}{g^4} = \frac{2\times\overline{z\dot{z}-\dot{z}}}{g^4}$;

and $y^{-5}\dot{y} = \frac{\dot{z}-z\dot{z}}{2g^4}$.

Therefore $\overline{g^2 y^{-2}+1}\big|^{\frac{1}{2}} y^{-5}\dot{y} = z^{\frac{1}{2}} \times \frac{\dot{z}-z\dot{z}}{2g^4} =$ $\frac{z^{\frac{1}{2}}\dot{z}-z^{\frac{3}{2}}\dot{z}}{2g^4}$, and its fluent is $\frac{\frac{2}{3}z^{\frac{3}{2}}-\frac{2}{5}z^{\frac{5}{2}}}{2g^4} = \frac{5z^{\frac{3}{2}}-3z^{\frac{5}{2}}}{15g^4} =$ $\frac{z^{\frac{3}{2}}\times\overline{5-3z}}{15g^4} = \frac{\overline{g^2 y^{-2}+1}\big|^{\frac{3}{2}}\times\overline{5-3g^2y^{-2}-3}}{15g^4} = \frac{1}{15g^4} \times$ $\overline{\frac{g^2+y^2}{y^2}}\Big|^{\frac{3}{2}} \times \frac{2y^2-3g^2}{y^2} = \frac{\overline{g^2+y^2}\big|^{\frac{3}{2}}\times\overline{2y^2-3g^2}}{15g^4 y^5}$, which was to be found.

2. Given the fluxion $\overline{a-fz^n}\big|^{\frac{1}{2}} z^{-\frac{7}{2}n-1}\dot{z}$, required its fluent.

Here $\overline{a-fz^n}\big|^{\frac{1}{2}} z^{-\frac{7}{2}n-1}\dot{z} = \overline{a-fz^n}\big|^{\frac{1}{2}} z^{-\frac{6}{2}n-1} z^{-\frac{1}{2}n}\dot{z} =$ $\overline{az^{-n}-f}\big|^{\frac{1}{2}} z^{-3n-1}\dot{z}$.

Put $az^{-n}-f = y$;

then $z^{-n} = \frac{y+f}{a}$;

also $z^{-3n} = \frac{\overline{y+f}\big|^3}{a^3}$;

in

in fluxions, $-nz^{-3n-1}\dot{z} = \frac{3\dot{y} \times \overline{y+f}\,\big|^{2}}{a^3} = \frac{y^2\dot{y} + 2fy\dot{y} + f^2\dot{y}}{a^3}$

$$\text{and } z^{-3n-1}\dot{z} = -\frac{y^2\dot{y} + 2fy\dot{y} + f^2\dot{y}}{na^3};$$

therefore, $\overline{az^{-n}-f}\,\big|^{\frac{1}{2}} z^{-3n-1}\dot{z} = -\frac{y^{\frac{5}{2}}\dot{y} + 2fy^{\frac{3}{2}}\dot{y} + f^2 y^{\frac{1}{2}}\dot{y}}{na^3}$;

and its fluent is $-\frac{\frac{2}{7}y^{\frac{7}{2}} + \frac{4}{5}fy^{\frac{5}{2}} + \frac{2}{3}f^2 y^{\frac{3}{2}}}{na^3} = -\frac{y^{\frac{3}{2}}}{na^3} \times$ $\frac{30y^2+84fy+70f^2}{105} = -\frac{\overline{az^{-n}-f}\,\big|^{\frac{3}{2}} \times 30a^2z^{-2n} + 24afz^{-n} + 16f^2}{105na^3}$

$= \frac{-1}{105na^3} \times \overline{\frac{a-fz^n}{z^n}}\,\Big|^{\frac{3}{2}} \times \frac{30a^2 + 24afz^n + 16f^2z^{2n}}{z^{2n}} = -$ $\frac{\overline{a-fz^n}\,\big|^{\frac{3}{2}} \times 30a^2 + 24afz^n + 16f^2z^{2n}}{105na^3 z^{\frac{7}{2}n}}$, which was to be found.

J. A.

LVIII. *Proceedings of Learned Societies.*

ROYAL SOCIETY.

April 30. A LETTER to the President from Capt. Maunsell was read, describing the peculiar appearance of three coronæ or suns which he observed at Plymouth, some time since. The author had often seen two coronæ, but never before three; the rainbow colours which formed these solar circles were in the inverse order in which they usually appear.

May 7. A very long paper, communicated by Mr. Brown of the Linnean Society, from Dr. Allman, on the figures of the tubes and pores of plants, was read. Dr. Allman having been led to investigate the cells and tubes of plants during a course of botanical lectures, observed that they might all be reduced to some regular geometrical figure. He then proceeded to demonstrate mathematically that the various tubes of plants necessarily assume octahedral, dodecahedral, or other geometric figures, either simple or combined. In the conclusion of this paper, which does not admit of analysis, Dr. A. acknowledged the merit of the labours of Mirbel and Decandolle on this branch of vegetable

vegetable anatomy, although his own researches had commenced long prior to the appearance of their respective works.

May 14. A letter from the indefatigable Mr. T. A. Knight to the President was read, describing his experiments on the tendrils of plants, and investigating the cause of their apparently rational inclination to adjoining objects for support. Mr. Knight tried a number of creeping plants in a green-house, and also the tendrils of vines; he exposed them in various positions with respect to the sun or light, and found that they all invariably receded from the stronger light, and attached themselves to those objects in the shade, or, if no other object presented itself, to the dark side of their parent stems. Hence he was induced to conclude that the action of light on the tendrils contracted the vessels on the sides exposed to it, and occasioned not only the spiral convolutions, but also that tendency to fix on obscured or shaded objects. On this principle he accounted for all the curious instinct-like motions of young tendrils in a manner purely mechanical, and positively denied them any sensitive or elective motion whatever.

The Society then adjourned over the holiday-week till Thursday the 28th of May.

LONDON PHILOSOPHICAL SOCIETY.

The meetings of this Society in April were chiefly occupied by an examination of Mr. Godwin's assertion, that Gratitude is no part of Virtue, and by a Lecture on Vision.

The numerous speakers, and the variety of ingenious opinions delivered and most ably supported on the former interesting topic, exclude our attempting with any degree of justice to present to our readers even a decision of the question. However we may differ from the theories advanced by many firm supporters of this Society, we cannot withhold our slight meed of praise for the zest of science displayed by their ardour in canvassing their various hypotheses; and at the same time feel fully impressed, that it is by such candid and liberal investigations of the different topics of Moral Philosophy, that we shall be able to dispel the gloomy and oppressive mist of scepticism, and accelerate our progress towards the meridian of perfection.

The Lecture on Vision was delivered by Mr. T. Pettigrew, and of which we shall give a short account. He began by observing, that prior to entering upon the physiology

logy of an organ, it is necessary to consider its anatomy: the lecture, therefore, commenced by a very accurate and perspicuous description of the anatomy of the Eye, and its adjacent parts. As he proceeded to demonstrate the various parts of this most beautiful organ, he noticed the appearance and peculiarities of them in different animals, showing their adaptation to the elements in which they exist.

Having explained the anatomy, Mr. P. proceeded to elucidate the action of the eye by physical experiments, and, after examining the nature of light and colours, applied it to the subject of vision. Here he enlarged on the power of the eye, by which it adjusts itself to the distinct perception of objects; and having noticed the opinions of Kepler, Le Cat, Des Cartes, Young, Pemberton, and some others, from the lately discovered muscle, by Mr. Campion, in an eagle, which is attached to the sclerotica, capable of producing the change in the focal distance, inferred that something analogous might exist in the human species, which would perform the three changes suggested by Mr. Ramsden and Mr. Home, viz. a motion of the crystalline lens—an elongation of the axis of vision—and an increase of curvature in the cornea.

From this subject the learned author proceeded to consider the theory of Hartley, on the manner in which the rays of light in falling upon the bottom of the eye excite *vibrations* in the tunica retina, which he seemed much disposed to coincide with;—the myoptic and presbyoptic states of the eye, with their remedies;—and the manner in which the optic image is reverted. After examining the different suggestions on this latter important subject, he determined the theory of Mr. A. Walker, of Edinburgh, to be the most rational and deserving of attention. We shall close this article by submitting a few extracts from Mr. W.'s work, selected by the lecturer*.

Mr. W. supposes "the eye to be acted on by light precisely as some kinds of the reflecting telescope, which, after receiving the image inverted upon its interior lens, reflects and reverses it upon its exterior lens, and permits it to be seen in its natural situation. In the same way, the interior part of the retina, having received the image inverted, reflects, reverses, and presents it in its natural position upon its anterior part."

"The anatomical fact, that, at the posterior part of the

* See Archives of Universal Science, vol. ii. April 1809, p. 162.

retina,

retina, its arachnoid, pulpy or most sensible lamina is covered on the side which is toward the vitreous humour by a more consistent, vascular, and less sensible portion, while the anterior part is exquisitely delicate and fine, tends to confirm this theory. It receives also additional confirmation from the circumstance, that the transparent retina thus laid over the black pigmentum, and more especially over the tapitum, exclusively occupying this part in some of the inferior animals, must form the most perfect reflector."

"Thus doubtless it is that that portion receives no impression from the image, and that the anterior extremity of the nerve, which is in all cases the most sensible, is alone impressed by a natural and correct picture of the external object, and transmits it to the sensorium."

"The physiological fact also, that the anterior part of the retina cannot be impressed even by a single direct ray from without,—and that, unless it receive the image reflected, reverted, and in its natural position from the posterior part, as I have described, it must be apparently useless,—is almost a decided confirmation of the theory I have suggested."

"A confirmation of this theory, however, still more decisive than these, yet remains. It appears that posteriorly the retina is entirely insensible where the optic nerve enters, as at that part we have no sense of vision."

"Consistently with the theory just delivered," Mr. W. concludes, "that we have from this circumstance a decided proof that the posterior part of the retina is utterly insensible, since, at the entrance of the nerve where it exists in the greatest quantity, it can be demonstrated to be so; and, that vision is wanting at this spot precisely because, where the nerve enters, there is no choroides to reflect the rays to the sensible interior portion."

Thus he conceives the optic image is reverted. It afforded us much pleasure to hear it intimated, that comparative vision will form the subject of another paper, as probably an attentive examination of this organ in the more simple (if we may be allowed the term) animals may throw some light on so interesting and important a branch of Physiology.

May.— Mr. Clarkson has this month delivered two Lectures on Physiognomy. His object in giving them was to define accurately the expressions of Physiognomical Character, and to prove that they formed, if accurately studied, a species of universal character; thus paving the way for the

the future progress he intends to pursue, in analysing the Hieroglyphical and investigating the Philosophical Language.

He began by remarking the rapid conquest which the theory had made over incredulity since the time of Lavater; and stated it as a proof of its general soundness, that it should not only be tacitly assented to by the learned, but be received as an axiom (which had really been the case) into ordinary journals and newspapers.

Mr. Clarkson conceived that Lavater had not reduced physiognomy to a science by induction and logical analysis, and this was the great desideratum for which he had undertaken the subject. The basis on which he founded his superstructure was, that we judge of every thing in the world, of animals, vegetables, and minerals, by superficial appearances. This superficial judgement is therefore as correct, with regard to man, as any other part of matter of which he forms a portion. But it does not involve the consequence, that human nature may read as in a volume, from the index of the face, the past or future history of an individual subject. Undoubtedly, Mr. C. observed, an unerring physiognomical judgement must be an attainment of long and laborious initiation; for, if every individual of all those numerous multitudes who have by turns possessed the globe differed in external characteristics, the shades of difference must be minute in the extreme for infinite variety to be written on so small a tablet as the human face:—still, if the infinite variety of characters in the Chinese or Hieroglyphical languages could be faithfully distinguished, those of the face are equally capable of distinction;—they are more so, because the roots of these characters, viz. the Passions, are known to all men:—the modifications of these roots, therefore, are all that remain to be understood.

Mr. C. then entered into a distinction between Pathognomy and Physiognomy. The first he defined to be passion in action, the latter in quiescence. The former was acknowledged by all, the latter denied by few; but if it could be proved that certain lineaments were the provinces of certain emotions and passions, an immoveable fulcrum was obtained on which to rest the physiognomical lever,—because nothing remained but to prove that the admitted action left traces proportionable to the power exerted. After having demonstrated the former point from paintings and from plates of the passions, he proceeded to prove the latter by syllogism as well as by experience. For if the nerves and

and muscles, which are the media of internal action, be material, they must be subject to all the effects of material action, to tenuosity, to rigidity, to expansion, to contraction; and the traces left upon them will be more or less strong in proportion as the action is more or less vehement, more or less reiterated. He next exhibited instances from painting, in which the milder passions and qualities might remain stamped upon a face in quiescence, such as benevolence, love, courage, and sorrow; and observed, that if this point was granted with regard to all the passions, more was granted, generally speaking, than what physiognomy demands; because it was not to be supposed, that a man who was struck with sudden panics repeatedly would by any repetition retain the haggard gaping look of Fear, or that a being who expressed his pride or his contempt with the most demoniacal extension of muscle, would retain that expression in all its disfiguring dimensions in a state of quiescence. Physiognomy did not require such a concession: she merely demanded assent to this simple proposition, That if positive lineaments in a state of rest approach the form which they assume in action, the more or less will the individual who possessed them be characteristically stamped with a propensity to such feelings and to such sensations.

Mr. C. then proceeded to mark out the provinces of the triple existence of man upon his face, agreeing with Lavater in assigning the forehead to intellect; the cheeks, the nose, and the lips, to moral or sentimental; and the chin and throat to animal existence; but differing with him in considering the harmony of this triple existence, that is, its coequal diffusion over every portion of the frame as the cornerstone of Physiognomy. For what is gained, he asked, when the fact is admitted, that the finger of one man will not harmonize with the hand of another, or the nose of one individual will not congenialize with his neighbour's features? The old objection of the Antiphysiognomist will immediately recur: 'I grant the individuality of all human forms, but I doubt the connexion of internal organization with that individuality.' The argument, therefore, merely goes to prove, that there is as great a difference between the mental as between the personal characters of mankind, and not that the mental is influenced of necessity by the personal. Indeed, if it were necessary to prove this harmony, the argument of Lavater was supererogatory; because any one who frequents a theatre, or a masquerade,

masquerade, is aware that the substitution of an eyebrow, or a false nose, will baffle personal recognition as strongly as if the face was disfigured by a mask.

To prove the proposition that the three existences of man had their distinct provinces of the face, Mr. C. observed, that with regard to intellect, the mere fact that the forehead was the superficial boundary of the brain, that is, the visible boundary, (for with the invisible, as far as regarded physiognomical practice, there was no necessity to interfere,) substantiated the deduction if the preceding premises were true, which regards it as the tablet and mirror of intellect. Experience was the best argument, that sensitive or moral existence acted on that portion of the face which occupies from the brows to the mouth; and no one could doubt the fact who had ever seen the eyes lighted up by love or dimmed by sorrow; that had ever beheld the cheeks irradiated by joy, flushed by hope, dimpled by benevolence, or *excavated* by envy, jealousy, or ambition. Animal life, the lowest species of existence, next drew the attention of the learned Lecturer, and this, by demonstration as well as by experience, would be found to reside in the lower part of the human face occupying from the mouth to the throat. That this was a fact, he said, independently of other evidence, Anatomy, at once the nurse and sister of Physiognomy, loudly and strongly attests;—she attests, that those portions of the frame in which animal strength resides, are concatenated with the muscles that move the arm and chin;—she demonstrates, and Pathognomy cogently pourtrays the demonstration, that in vast exertions of animal power the under jaw is firmly knitted to the upper: that in all cases of bodily debility, or mental apathy, the under jaw drops and depends;—she points to the well-known influence of old age, in still further augmenting the visibility of this depending characteristic; and she appeals to Death itself, whether the total laxity of the under jaw be not its most positive and most undeniable symptom.

After making some remarks on the impracticability of the theory of Gall as applied to living beings, inasmuch as the organs by that Professor are diffused over the whole surface of the scull, the Lecturer proceeded to define the gradated differences between intellect and inanity, observing that, if his foregoing premises were true, the difference between the ratiocinative faculties of brutes and men should be marked in the boldest delineation on the foreheads of the different species. The difference, in short, consisted in this, that man has a forehead slightly inclining from

from the perpendicular, and the brute either possesses no forehead at all, a most decisive mark of inanity, or presents it to view in a line nearly horizontal or parallel with the earth. Hence, then, a deficiency of forehead is analogous to a deficiency of intellect; and from this proposition results another of still greater importance, that the nearer the forehead of brutes approaches the line described by that of man, the greater must be their characteristics of sagacity, of memory, of sensibility; and this is instanced in the elephant, the dog, and the monkey. The approximation or deviation, therefore, affords a scale perfectly unembarrassed for the physiognomist.—The main result of the whole argument was this: that a receding forehead, that is, when compared with the usual perpendicularity of human foreheads, implies a defective gradation of intellect; and, when the line so receding passes a certain point, involves a necessary incapacity in the individual.

It must not be supposed, however, continued the Lecturer, that a rectilinear forehead affords the only real standard of perfection. Where there are internal organs originally active, there must be prominences and curves. The greater the curve, the greater will be the power; and the more distinct and clear the external delineation, the more singleness of internal energy in the metaphysical faculties of the brain. Hence, then, a concavity of forehead betrays a greater want of intellect than a perpendicularity, and the latter than a convexity, that is, under certain modifications and restrictions. He was aware that the Greek statues of the gods exhibited a forehead distinguished by a perpendicularity of outline continued throughout the whole extent of the nose: but even this fact, though apparently hostile, was in reality coincident with this theory; for the Greeks aimed at conferring a calm intellectual self-absorption on their deities, as well as a privation from debasing passions. Instead, therefore, of prominences, which are the stamps of effort, they selected right lines; and they produced by that selection the anticipated effect.

Mr. C. concluded his first Lecture by exhibiting a scale of the gradation of intellect, from the horizontal line of forehead peculiar to the lowest brutes, to the perpendicular line of the Greek ideal: by this it appeared, that the European forehead retrogressed from the ideal ten degrees, the Asiatic (a fact pregnant with moral conclusions) about fifteen, the Negro twenty, the Peruvian twenty-five, the Ourang-outang thirty-five. He alluded to the argument of Negro-nonprogression, drawn chiefly from the foreheads of that

that race; and after mentioning his desire of appropriating a single lecture to the defence of their *progressive* powers, observed, that the exhibition of the physiognomical scale, he then produced, decided against the opposite theorists in a striking degree,—for the Peruvian was now below the Negro in the physiognomical indication of mental powers; and it was a notorious fact, that the Peruvians were rapidly advancing up the great ladder of civilization, from the lowest degree of the scale in which savage existence mingles with that of brutes at the period of Pizarro's invasion*. The line of the forehead, therefore, did not prevent improvement, but accompany degradation.

In his second Lecture Mr. C. proceeded, from an analysis of intellect in the abstract, to an analysis of intellect in the detail; observing, that if the intellect have various distinct metaphysical powers, such as memory, perception, imagination, and judgement, the organs of the brain, which are the media of their action, must correspond with them, not only in their distinct existence, but in their distinct position: otherwise, the connexion between brain and intellect would not be positive, but partial. He then proceeded to a learned metaphysical analysis of Perception, stating it to be a faculty peculiar to childhood; and concluding, that it was necessary to express some proof of its existence on the forehead of the child. After stating the striking difference between the projecting curve of the child's forehead and the retiring line of the adult, he observed, that the convex of the former was repressed by a horizontal sinus or indenture, as the faculties developed themselves, and that the consequence of this indenture was the formation of an arch above the brows, which increases as the lower arch recedes. From hence he concluded, that the upper or retiring portion of the forehead was the province of perception, and the lower or advancing portion the territory of the reflecting energies maturing or confirmed. He next remarked, as collateral testimony, the projecting rotundity of forehead evident in the faces of idiots, which Lavater has already observed. This proved them the creatures of mere sensation; and immaturity of intellect always accompanied the external sign.—He then adverted to a more pleasing collateral testimony. It had been allowed, he said, by most philosophers, that women were superior to men in the perceptive faculties, though

* We believe that the practice of the Peruvians with their infants, of placing the head between boards, firmly confined, to mould them agreeably to their ideas of beauty, materially influences the line of direction.

 inferior

inferior in the reflective; that they acquired frequently by a glance of thought, what men acquired by elaborate and slow research. After detailing the benefit which might result from the refinement of this instinctive felicity of reasoning, he inquired, whether it could be traced in the external lineaments? Nothing could be more satisfactory than the answer, for the female forehead uniformly differs from that of man; and the difference consists in this, that in the forehead of man there is a strong indenture indicative of application: in woman there is none. The former is rectilinear, the latter curvilinear,—but curvilinear without being projecting. In the former there are protuberances and broken lines: in the latter the beautiful unbroken arch, not only of the profile but of the eyebrows, demonstrates the superiority of the perceptive faculty, chastened more or less as it advances or recedes.

Imagination, the next division of the intellect, the learned Lecturer stated, was a modification of perception and memory. It must, therefore, be sought for in the upper arch of the forehead.—Gall had placed wit in the two angles of that upper part, and wit was the effect of imagination. It had been before observed, that a retreating line was peculiar to ardency of thought;—a straight line to judgement;—a projecting line to immaturity of idea. When, therefore, the curve peculiar to perception was felicitously mingled with the slightly retiring line peculiar to production of ideas, there was the character of Imagination, and such was the forehead of most females; and when the lower arch of the forehead indicated a commutual expansion of the organs of memory and judgement, there was the constitutional ideal of a poetical construction.

It follows, therefore, that the lower arch of the forehead (the protuberance of which is as remarkable in the Greek ideal as in the real busts of great men) must be the seat of memory and judgement. Indeed, Gall and Lavater not only both concur in this proposition, but afford a clue to discover the distinct position of these two organs. Lavater has remarked, that he never observed any one with projecting eyebrows who was not a calculating and enterprising genius; and that a perpendicular indenture of the forehead above the nose, was equally indicative of acuteness and discrimination. Professor Gall, though he has confounded the organs of memory and judgement, concurs singularly with Lavater; for he places the organ of calculation, which depends evidently on memory, at the extremity of the eyebrows; and the organ of association relative

relative to places and things, which is nearly allied to the faculty of judgement, on either side of the perpendicular indenture of the forehead. So much for anatomical coincidence. Experience is equally convincing. For the forehead of all eminent men is strikingly marked with the sinus described, among which none are more remarkable than Sterne, Johnson, and St. Evremond. Besides, it is certain, in all application or study in which the judgement is principally concerned, there is a contraction of the brows, and the consequence of that contraction will be to deepen the indenture.

The Lecturer then proceeded to an ingenious exposition of the different forms of the eyebrows, stating them to be strong hieroglyphs of the mental character, and exhibiting drawings of them under different gradations, from the elevated stare of astonishment to the arched curve of wit; the irregularly depressed line of sorrow and debility, or the more regular depression of intense application. A scale therefore of gradations might be formed, and the knowledge of man as an intellectual being reduced to science.

[To be continued.]

WERNERIAN NATURAL HISTORY SOCIETY*.

At a meeting of this society, on the 22d of February, a communication from the Rev. Mr. Fleming of Flisk was read, describing the mineralogical appearances which occur on the north bank of the Frith of Tay, from Dundee up to Kingoodie quarry. The rocks are claystone, claystone porphyry, felspar porphyry, greenstone, sandstone, and amygdaloid. The sandstone occurs in bason-shaped cavities in the porphyry, and contains subordinate beds of greenstone; but he deferred giving any decided opinion concerning the geognostic relations of these rocks till he should examine the south shore of the Frith of Tay.

At the same meeting, the Secretary read a communication from Mr. Macgregor, Surgeon to the 25th regiment, giving an account of the mineralogy of the district around the town of Lanark, particularly at the celebrated falls of Cora Lin and Stonebyres. Near the former, porphyry-slate and felspar-porphyry occur. At the latter, the waters are poured over beds of fine-grained sandstone, which, in descending, gradually becomes coarser in texture, till it passes into a conglomerate, consisting of masses of quartz, jas-

* This report was omitted in last number by mistake.

per, splintery hornstone, flinty-slate, and clay-slate. Near Netham Bridge, the traces of a coal deposition, and a portion of a coal-field make their appearance; many alternating beds of sandstone, bituminous shale and clay ironstone occurring along with thin beds of slate-coal and cannel-coal. Mr. Macgregor stated it to be his opinion, that the sandstone exposed on the banks of the Clyde and of the Mouse river near Lanark, belongs to one and the same formation; and that the Mouse has gradually scooped out the present channel, in the same way as the Clyde is supposed to have done, and that there are here no marks of any violent convulsion of nature, as some have imagined.

An extract of a letter from Lieutenant Huey of the 73d regiment was also read, mentioning the circumstance of a large marine animal, supposed to be about 30 feet long, and shaped like a snake, having been observed from a ship in lat. 38° 13′ S. and long. 5° E.

ROYAL MEDICAL SOCIETY, EDINBURGH.

All Members of this Society are invited to write an *Experimental Essay* on the following subject:

"To determine by experiment, what substances are exhaled by the skin; and the changes, if any, which they produce on the surrounding air."

The dissertations are to be written in English, Latin, or French, and are to be delivered to the Secretary on or before the 1st of December 1813, (being the year succeeding that in which the subject is proposed.) The adjudication will take place in the last week of February following.

To each dissertation shall be prefixed a motto, and this motto is to be written on the outside of a sealed packet, containing the name and address of the authors. No dissertation will be received with the author's name affixed; and all dissertations, except the successful one, will be returned, if desired, with the sealed packet unopened.

KIRWANIAN SOCIETY OF DUBLIN.

April 1.—The reading of a long paper by M. Donovan, Esq., member of the Kirwanian Society, entitled "Observations on the Inadequacy of the Hypotheses, at present received, to explain the Phænomena of Electricity," was commenced.

After a statement of Dr. Franklin's doctrines, Mr. Donovan referred them to five general and ultimate propositions. He conceived that the elasticity attributed to the electric fluid was assumed on insufficient grounds, and brought

brought forward an experiment in which bodies similarly electrified attracted instead of repelling each other. He then argued in opposition to Dr. Franklin's opinions concerning the existence, equal distribution, and relative proportion of electricity in bodies; he showed that the train of phænomena depending on attraction and repulsion are not explained by this hypothesis; and that the reasonings on the subject are contradictory to facts, and against themselves.

April 15 the reading was continued.—Mr. Donovan conceived that the impermeability of glass, as assumed by Dr. Franklin, was incompatible with some of the Doctor's own principles; and, if impermeability were proved, that the fact would offer insurmountable obstacles to the admission of the remaining principles of the hypothesis. He also produced an experiment which seemed decisively to prove that glass is permeable. He then proceeded, at some length, on the doctrine of *plus* and *minus*, and made an experiment to prove that Leyden phials when fully charged do not indicate the states of electricity usually attributed to them: he showed that when a phial is supposed to contain an *excess*, it will manifest unequivocal indications of a *diminution* on the *same* surface; and noticed a variety of other phænomena contradictory to the hypothesis. He concluded his observations on Franklin's hypothesis, by making some remarks on its insufficiency to explain excitation.

May 13. The reading was continued.—The next hypothesis which came under examination was that of Ecles, which has been generally attributed to Symmer and Dr. Priestley. After stating the hypothesis, he proceeded to examine its principles. Some observations were first made on the improbability of the existence of two distinct fluids. The author then proceeded to show, that even allowing the properties assumed as belonging to these fluids, yet still the phænomena of attraction and repulsion are not explained; and that some consequences fairly deduced from the hypothesis are contradicted by well-known facts. He made some remarks on Ecles's objections to the permeability of glass as maintained by Dr. Franklin, and showed that these objections were invalid. He further observed, that strong objections to some parts of the hypothesis arise out of allowing permeability to glass. It was next shown that on these principles, the Leyden phial, in the operation called charging, should have even its natural quantity diminished to one half, far from having one of its powers doubled as is supposed in the hypothesis. He concluded his objections

to Ecles's doctrines with observing, that the great principle upon which the whole is founded is demonstrably false.

At the same meeting a paper, by Dr. Ogilby, (one of the vice-presidents,) "On a Formation of Porphyry which occurs in the counties of Antrim and Down," was read. The paper was accompanied by a collection of specimens, illustrative of the series from the older to the newer beds of this formation. After some general remarks upon the porphyries of the Wernerian Geognosy, which have been confined to the class of primitive rocks, it was stated as probable, in consequence of Professor Jameson having recently discovered transition and flœtz porphyries in Scotland, that still more extended observation might develop a series from the oldest or primitive porphyries of Werner, through the transition and flœtz observed by Jameson, to others of still later formation, or approaching nearer to the oldest alluvial products. A considerable extent of country between the small towns of Doagh and Kells, in the county of Antrim, called Sandy Braes, and which had been first noticed (though never described) by the late celebrated Dr. Mitchell, consists of porphyritic rocks. Dr. Ogilby has since observed a considerable detached portion, which he considers of the same formation, near the town of Newton Glens, on the NE coast, and has also found traces of it near the towns of Broughshane and Templepatrick, and at Killymorris in the same county; and, from the specimens deposited in the Dublin Society's Museum, it would also appear to occur near Hillsbro', in the county Down.

After some remarks upon the general appearances of the hills composed of these rocks, which are low, irregular and obtusely conical in their form, the series of minerals was described in the following order, commencing with the lowest or oldest member he could discover of the series. 1. Porphyritic clay-stone, the basis of which passes on the one side into clay of little induration; and on the other into compact felspar, and rarely, a mineral approaching in its characters to red jasper. 2. Felspar porphyry. 3. Porphyry with a basis of compact felspar and finely disseminated hornblende, which may be called Greenstone Porphyry. Some specimens of this rock showed a strong tendency to the porphyry slate of Werner. 4. Pitchstone and pearlstone porphyry, in some of the specimens of which the passage of pearlstone into pitchstone was very distinct. A transition of the pitchstone into hornstone porphyry was also observable. The semi and common opal of different shades of yellow, and apparently of cotemporaneous formation

formation with the containing rock, occur not unfrequently. It has not been fully ascertained whether the pitchstone and pearlstone porphyries occur in beds or veins, but the former appears the more probable. The top of Cairnairney-hill at Sandy Braes, and of Courtmartin, Tiveraw, and the Knockins at Newton Glens, Dr. O. considers as the newer beds or deposits which remain, of this formation. A remark which appears to merit attention, was made respecting the quartz and felspar crystals which occur in these porphyries. The felspar in particular has considerable lustre, hardness, and regularity, and may be considered as the glassy subspecies of Werner, in the newer beds of this formation as at the top of Cairnairney, while these characters in general diminish the nearer we approach to what are considered the mechanical deposits, or the older beds of the series. The paper concluded with some theoretical remarks relative to the geognostic situation and mode of formation of porphyry. If the trap rocks of Antrim belong, as is commonly supposed, to the newest flœtz formation of Werner's arrangement, it will then follow that this porphyry is newer than any hitherto observed by Professor Jameson, and will probably hold a place in the system under the name of the Newest Flœtz Porphyry. The answer to Mr. Jameson's query respecting the pearlstone of Sandy Braes will be then obvious.

At the fourth meeting held on the 20th, Dr. Ogilby submitted to the Society some remarks upon Mr. Davy's late proposal of rejecting the oxymuriate of lime from the process of bleaching, and substituting the oxymuriate of magnesia, and he presented the results of several experiments upon this subject.

After some observations upon Mr. Davy's notion that the residual muriate of lime, which remains in solution after the usual process of steeping in the oxymuriate, possessed a caustic property and destroyed the fibres of the cloth, it was argued that the singular mode of reasoning on the assertion made use of by Mr. Davy, "that if a strong solution of muriate of lime rendered the cloth unsound, a weak one ought to be proportionally detrimental," could not be for a moment attended to by the bleacher, without rejecting every article essential to his process, as potash, sulphuric acid, &c. which in their concentrated state will dissolve or burn the cloth. Notwithstanding, however, that Mr. Davy had been guided in making his new proposal by views of the subject altogether erroneous, the action of muriate of lime on linen cloth was deemed

worthy of trial, and accordingly cuttings of full bleached linen were steeped in solutions of the neutral salt, of different degrees of strength, some of them nearly saturated; and after continuing the process with fresh solutions for four times, each twenty-four hours, in every experiment, and at the end comparing the linen with some of the same which had not been steeped, it was found perfectly sound, and not perceptibly reduced in the texture. It was therefore stated as probable, that if accidents ever occur in the process it must be owing to disengaged muriatic acid, or to negligence in washing the cloth after the operation of steeping.

The assertion of Mr. Davy that the oxymuriate of magnesia has superseded the use of that of lime, in Ireland, was contradicted. Not a single bleacher in the country uses it; for, if eligible even, it is not within his reach, magnesia being 2*s*. or 3*s*. per pound. It appears from the article *Bleaching*, in the Edinburgh Cyclopædia, that the oxymuriate of magnesia has been employed by the calico printers of Scotland, in the process of clearing, for some time back. Mr. Davy is not mentioned as the proposer of it in that article.

IMPERIAL INSTITUTE OF FRANCE.

[Continued from p. 244.]

The author adds the following reflections which are completely independent of the theory of probabilities, on which he founded the preceding reasoning.

The system of elements which most reduces the errors will certainly be the most probable, if all the observations be equally accurate: but if there are two systems of elements, one of which represents, in the best manner, a certain number of observations, and the other of which best agrees with other observations, then we fall again into perplexity and uncertainty, and we may propose innumerable systems for lessening the errors: we may instead of the small squares propose small equal powers of any given order, but the squares are always the most simple—the other powers would lead us into endless calculations. If the exponent pair of powers is infinite, we recur to the method which demands that the extreme errors shall be *minima*.

He finds that the principle of Boscovich returns to the method in which it might be proposed to satisfy rigorously a number of equations equal to that of the unknown quantities, and in which we should only consider all the rest as so many proofs to enable us to judge of the precision which

which we may flatter ourselves we have obtained—adding, as a second condition, that if the sum of the errors, taken with their natural sign, be reduced to zero, we cannot obtain more accurate results than by a number of equations of a less unity than that of the unknown quantities.

To conclude, M. Gauss states that the principle of the small squares which he has made use of since the year 1795, was published by M. Legendre in 1805 in his Memoir upon Comets.

From this declaration a new question arises. In speaking of the above method, both authors use the expression of *mon principe des moindres carrés.* To whom belongs the merit of this principle which M. Gauss made use of 16 years ago, and which M. Legendre seems to have become acquainted with so recently? The answer is very simple. It is impossible that M. Legendre can be under any obligations on this point to M. Gauss, who had not published any thing: we are convinced that M. Gauss had discovered the theorem, but it is equally clear that M. Legendre not only discovered it for himself, but was the first to make it public.

Finally, we may remark that M. Laplace, although he has in no shape laid claim to the honour of the discovery, has at least directly demonstrated and clearly developed, by an analysis peculiar to himself, a truth which was scarcely suspected; namely, that the corrections furnished by the methods of the small squares are the most precise which can possibly be procured. We shall add, for the benefit of those who are familiarised to astronomical calculation, and who use the processes of transendent geometry, that it is sufficient to follow attentively the course and mechanism of the numerical calculation of M. Legendre, in order to be thoroughly convinced that his method has all the advantages which M. La Place's analysis ascribes to it. To conclude: as the results obtained are only the most probable, the calculator ought not to dispense with ulterior proofs. These cannot be obtained except by a rigorous calculation made upon the elements corrected and compared directly with all the observations. In fact, the equations upon which he wrote, are only approximations, since they are linear; and it is not impossible that this revision will furnish him, for his elements, with slight modifications, which, without carrying him far from the results of the small squares, will give still more precision to his Tables.

[To be continued.]

LIX. *In-*

LIX. *Intelligence and Miscellaneous Articles.*

Dr. Buchan has recently published a work with the following title: "*Bionomia; or,* Opinions on Life and Health." This small work is intended as the præcursor of a Course of Lectures on the Philosophy of sentient Beings. It abounds with sensible observations on vitality, or the principles of life,—a subject which the author regrets has been neglected by the moderns. He adds, the study of inert matter has supplanted that of animal life. Chemistry and mineralogy are almost the sole objects of attention.

The Russian counsellor Bradsky has obtained a reward from his sovereign for a method of vaccinating sheep. He dissolves the virus in water, and steeps in it a piece of thread, which is afterwards drawn through the extremity of the ear, and left hanging like an ear-ring. At the expiration of a few days, the inoculated sheep has the same symptoms as a child who has been vaccinated. The most favourable time for this operation is the month of September.

Theatre of Anatomy, Blenheim Street, Great Marlborough Street.—The Summer Course of Lectures on Anatomy, Physiology, and Surgery, will be commenced on Saturday, the 6th of June, at Seven o'clock in the Morning, by Mr. Brookes.

Anatomical Converzationes will be held weekly, when the different subjects treated of will be discussed familiarly, and the Students' views forwarded.—To these none but Pupils can be admitted.

Spacious apartments thoroughly ventilated, and replete with every convenience, are open from Five o'clock in the Morning for the purpose of dissecting and injecting, where Mr. Brookes attends to direct the Students, and demonstrates the various parts as they appear on dissection.

The inconveniences usually attending anatomical investigations, are counteracted by an antiseptic process.

St. George's Hospital and George Street, Hanover Square. Medical and Chemical Lectures.—On Monday, June 1, as usual, the Courses on Physic will recommence at Eight o'clock in the Morning, and the Chemical at a Quarter after Nine. By George Pearson, M.D. F.R.S. Senior Physician to St. George's Hospital, of the College of Physicians, &c. &c.

Clinical Lectures on the Patients in St. George's Hospital are given every Saturday Morning at Nine o'clock.

Dr.

Dr. Squire's Lectures.—Dr. Squire will on Saturday, June 6, begin a Course of Lectures on the Principles and Practice of Midwifery, and the Diseases of Women and Children. Particulars may be known by inquiry at the Doctor's house, 30, Ely Place, Holborn.

LIST OF PATENTS FOR NEW INVENTIONS.

To Francis Purden, of the city of Litchfield, sadler, for his improved horse boot, for the preservation of sound and the restoration of contracted hoofs.—27th Feb. 1812.

To Joseph C. Dyer, of Boston, State of Massachusetts, one of the United States, now residing in Gray's Inn, London, merchant, in consequence of a communication made to him by a certain foreigner residing abroad, for an invention of certain machinery for cutting and heading of nails from strips or plates made of iron, copper, or any other metal capable of being rolled into plates.—4th March.

To Samuel Bentham, of Hampstead, in the county of Middlesex, civil architect, and engineer of the navy, for his new mode of excluding the water of the sea, of rivers or of lakes, temporarily during the execution of under-water-works of masonry or other materials, or permanently for the security of foundations, applicable for example to the construction of sea walls, wharfs, piers, docks, and bridges. —5th March.

To Charles Augustus Schamalcalder, of the Strand, mathematical instrument-maker, for certain improvements in mathematical instruments.—5th March.

To Felton Mathew, of Goswell Street, merchant, for certain improvements in the manufacturing of yeast.—5th March.

To Archibald Earl of Dundonald, for his method of preparing and manufacturing alkaline salts from vegetables the growth of the united kingdom of Great Britain and Ireland.—14th March.

To John Loach, of Birmingham, brass founder, for his improvement in the method of manufacturing claw, socket, and other kinds of castors, and also knobs and furniture for locks.—14th March.

To Sarah Guppy, wife of Samuel Guppy, of the city of Bristol, merchant, for certain improvements in tea and coffee urns.—14th March.

To William Henry Hart, of New York, one of the United States of America, now residing in London, gent. in consequence of a communication from a foreigner residing

siding abroad, for a new method or machine for cutting, cropping, or shearing woollen and other cloths, and the fur from peltry.—24th March.

To William Francis Snowden, of Oxford Street, in the county of Middlesex, engine-maker, for his mangle on an improved construction.—28th March.

To James Lawrence Darke, of Baldwin Court, Cloak Lane, in the city of London, merchant, for his method of preparing the various sorts of isinglass, such as book leaf, long staple, and short staple, and also cake isinglass from river and marine fish.—8th April.

To William Whitfield, of Birmingham, in the county of Warwick, steel-yard-maker, for his one-side compound lever steel-yard.—15th April.

To John Ashley, of Homerton, in the county of Middlesex, plumber, for his horizontal and vertical moving roaster.—15th April.

To John Leigh Bradbury, of the city of Gloucester, gentleman, and Charles Weaver, of the same city, pin-manufacturer, for their machine for heading pins.—15th April.

To Charles Fly Blunt, of Prujean Square, Old Bailey, in the city of London, engineer-draftsman, for his certain improved arrangements of machinery for the improvement of ships' fire-hearths, and an extension of the same to other useful purposes.—21st April.

To Graham Chappell, of Arnold, in the county of Nottingham, gent., for a lamp on a new construction, and a new method of using oil and wick therein.—28th April.

To Joseph Manton, of Davies Street, Hanover Square, in the county of Middlesex, gun-maker, for improvements in guns and pistols.—30th April.

To Edward Massey, of Cross Heath near Newcastle-under-Lime, in the county of Stafford, nautical instrument-maker, for certain improvements in the construction of chronometers.—30th April.

To John Thomas Thompson, of Long Acre, in the county Middlesex, camp equipage-maker, for certain improvements in the making of iron bedsteads and testers of every description.—30th April.

To Thomas Francis Dollman, of the parish of St. James's, in the city and liberty of Westminster, in the county of Middlesex, hatter, for his elastic round hat, made out of beaver, silk, or other materials.—5th May.

To George Smart, of Ordnance Wharf, Westminster Bridge, in the county of Surry, timber-merchant, for his

improved

improved method of preparing timber, whereby the same is prevented from shrinking.—5th May.

To Bassett Burrows, of Birmingham, in the county of Warwick, hatter, for his method of manufacturing water-proof hats.—5th May.

To Henry Higginson, of Wilson Street, in the parish of St. Luke, and county of Middlesex, esq., (in consequence of a communication made to him by a certain foreigner residing abroad), for a new method or methods of propelling boats or vessels with the aid of steam or any other power.—9th May.

To Col. Wm. Congreve, of Cecil Street, in the county of Middlesex, for his improved system of gun and carronade carriages.—11th May.

To Henry Errington, of the city of Bath, schoolmaster, for an instrument called the "Navigator's Sector," by which any person is enabled to ascertain the difference of latitude, departure from the meridian, and distance sailed, with the course; also to solve any problem, geometrically, that may be required to show the angles, hypothenuse, perpendicular, and base.—14th May.

To Edward Shorter, of Baron's Buildings, Blackfriars Road, in the county of Surrey, engineer, for various improvements in the construction of tunnels and subterraneous passages.—19th May.

To Jeremiah Dimmock, of Moor Croft iron-works in the parish of Bilston, in the county of Stafford, manufacturer of iron, for his new method of manufacturing iron—26th May.

Meteorological Observations made at Clapton in Hackney, from April 21, to May 20, 1812.

April 21.—Clear with *cumuli* and some *cumulostratus*.

April 22.—N. Cold wind, clear sky; then came *cumuli* sailing along, while flimsy *cirri* appeared higher: some *cumulostratus* afterwards obscured the sky at times.

April 23.—N. Clear; *cumuli* sailed over from the north; above them in a higher air appeared now and then a veil of *cirrus* passing over slower in the same direction, and assuming more or less of the fibrous texture, and here and there breaking out into *cirrocumulus* of little stelliform *nubiculæ;* afterwards *cumulostratus* and light *nimbi*. Clear night; drops of rain fell when there was no apparent cloud about seven o'clock.

April 24.—N. Clear early; *cumulostratus* and afterwards *nimbi* pouring snow and sleet passed over with the wind. In

In the afternoon large masses of cloud of cirrocumulative kind indicated warmer air, and we had a warmer and gentle shower at night.

April 25.—Clouds in two altitudes; much *cumulostratu* followed by rain, the wind shifting to the S.W.

April 26.—S.W. Rainy morning; in the evening *cirrostratus* stretched along in dense fibres, while rugged *cumuli* appeared in a lower air.

April 27.—S. Cloudy, with long and gentle showers of rain: temperature increasing.

April 28.—S. Rainy morning; in the evening it held up, and the moon appeared.

April 29.—Cold east wind again, and overcast sky.

April 30.—S.E. Cloudy and rainy, it held up at intervals.

May 1.—Fair day; clouds in two strata.

May 2.—E. Cloudy sky, and a cold wind in the morning; fine evening; light *cirrostratus* stretched along, little loose *cumuli* float slowly under.

May 3.—Sun out at times; light *nimbi* about noon; fine clear evening; a partial white stratus creeping on the ground in the marshes and neighbouring fields; scattered features of *cirrocumulus;* a golden sunset.

May 4.—S—N. Clear morning, afterwards a few clouds.

May 5.—S—S.E. Clear, and a few lofty plumose *cirri;* and afterwards *cumulostratus* obscured the sky; fair night.

May 6.—E. Dry wind; sky pretty clear with *cumuli.*

May 7.—E. Dry wind, and strong in the afternoon and night: few clouds, loose, ill-defined *cirrocumuli,* and *cirrostratus* lower.

May 8.—S. Much warmer than hitherto: the maximum of the thermometer 75° in the shade. Early, the upper masses of cloud showed a tendency to *cirrocumulus;* those lower increased into *cumulostratus;* the afternoon became clear with light features of *cirrocumulus,* &c.

May 9.—S.S.W. Very warm; *cirrus* scattered on high, with *cirrocumulus,* and haze; afterwards *cumuli* sailed under; *cumulostratus* formed and obscured the sky; the wind rose, got more westward, and a shower fell about five o'clock.

May 10.—Clouded sky, with a breeze from W.S.W. and occasional showers.

May 11.—W.S.W. Clouded early, then fair, with *cumuli* in different heights; the lower ones well-defined.

May 12.—W. Early light confused cirrose and cirrocumulative clouds above *cumuli;* afterwards *cumulostratus;* the

the sky seemed veiled with irregular folds of this cloud: rain in showers came on by five o'clock P. M.

May 13.—W. Fine early; clouds in two strata; rain with hail and thunder shower in the day; fine evening again.

May 14.—W.S.W. Fine clear morning; afterwards clouds in two strata obscured the sky with a haziness below. Petroid *cumulostratus*, &c. appeared, and showers came on, but the evening became fine.

May 15.—Fine veil of *cirrus* spread on high, while a sheet of partly *cirrostratus* and *cirrocumulus* appeared lower; partial detached *cirrostrati* also were seen; rain came on, and continued gently falling almost the whole day. After sunset a fine crimson blush appeared just above the occidental horizon.

May 16.—N. Fair day; early appeared *cirrus* breaking out into *cirrocumulus*, while *cirrostratus* also appeared lower, and *cumuli* still nearer the earth. Towards evening *cumulostratus* obscured the sky.

May 17.—N. Cold north wind and cloudy; small rain in the evening.

May 18.—Rain early, afterwards fine and warmer; the sky however was pale coloured, and *cirri* were scattered about above *cirrostrati*; a sort of loose flimsy beds of *cirrocumulus*, and lastly *cumuli*.

May 19.—S. Cloudy morning; *cumulostratus* followed by storms with thunder and lightning in the evening. The lightning continued all night; but the thunder, which began here about eight o'clock, ended before ten *.

May 20.—The different modifications appeared with occasional nimbification. Fine evening, with beautiful petroid *cumulostrati*. Lightning by night.

Clapton, May 21, 1812. THOMAS FORSTER.

* The storms of thunder commenced much sooner at Walthamstow than they were heard at Clapton. This would induce a belief that the storms were low in the atmosphere. At Epping, ten miles to the north-east, the thunder began and ended about the same time as at Hackney. From the accounts which I have often received of the time of the occurrence of storms in different parts of the country, I have been induced to think that frequently a simultaneous production of them took place in very distant masses of atmosphere. This can only be ascertained by noting down accurately the precise period of their commencement and time of their duration in different places. A circumstance to which I wish to call the attention of meteorologists.

METEORO-

METEOROLOGICAL TABLE,

BY MR. CARY, OF THE STRAND,

For May 1812.

Days of Month.	Thermometer. 8 o'Clock, Morning.	Noon.	11 o'Clock Night.	Height of the Barom. Inches.	Degrees of Dryness by Leslie's Hygrometer.	Weather.
April 21	42	54°	38°	30·05	46	Fair
22	40	50	35	29·99	40	Cloudy
23	37	48	40	·95	47	Fair
24	40	49	39	·89	56	Fair
25	40	47	42	·60	24	Showery
26	42	48	41	·50	10	Showery
27	42	48	47	·58	0	Rain
28	49	49	48	·62	0	Rain
29	46	50	47	·70	29	Cloudy
30	47	54	47	·75	32	Cloudy
May 1	46	55	46	·95	46	Fair
2	47	54	45	·78	44	Fair
3	46	54	45	·64	26	Showery
4	47	56	46	·66	61	Fair
5	48	60	48	·80	53	Fair
6	47	60	45	·92	46	Fair
7	48	55	49	·90	42	Cloudy
8	55	71	60	·75	70	Fair
9	66	70	56	·66	66	Fair
10	56	63	55	·60	36	Showery
11	54	62	54	·55	30	Stormy
12	55	58	53	·50	15	Showery
13	56	58	51	·49	27	Showery
14	54	57	50	·50	20	Thunder, showers
15	52	56	46	·86	29	Showery
16	46	56	46	·98	48	Fair
17	47	52	46	·99	0	Rain
18	47	52	46	·96	0	Rain
19	51	65	55	·75	42	Thunder in the Evening with remarkable vivid Lightning
20	52	67	57	·75	40	Cloudy
21	55	57	49	·80	0	Rain
22	42	59	44	·98	46	Cloudy
23	42	52	49	30·16	50	Cloudy
24	47	56	50	·25	36	Cloudy
25	56	62	57	·11	0	Rain
26	60	73	62	29·88	72	Fair

N.B. The Barometer's height is taken at one o'clock.

LX. *Some Account of the Methods of laying the Foundations of Bridges, &c. By the Author of "Some Account of the different Theories of Arches," &c. in the Philosophical Magazine for December* 1811.

The practice of laying the foundations of bridges in deep water, generally adopted by the ancients and moderns, has been to lay the piers dry, either by turning the water into a new course temporarily, or by the erection of a cofferdam round the site of the pier; so continuous, as to prevent the water interfering with the works after it had been once pumped out*. They have also practised another method somewhat more ingenious. The emperor Claudius practised it in erecting the port of Ostia; Draguet Reys, in erecting the mosque in the sea at Constantinople; and Sir Samuel Bentham is said lately to have introduced it into this country, in the construction of some works at Sheerness. A strong grating of wood-work covered with planking at once forms a floating raft, and the floor upon which the stone pier is to be erected: the pier is composed of stones well secured together and rendered by cement watertight: the whole body is made to float upon the water until it has advanced in height, so, that if it were sunk it should be above low-water mark, or higher, as might be found expedient: this levity is obtained either by the assistance of vessels to which the raft is attached by ropes; or by the pier being worked up with sufficient vacuities to render it specifically lighter than an equal bulk of water: the pier is then sunk either by letting the water into the vacuities, or by loosening the ropes (as the case may be), the bed of the river being previously prepared by machines of the description of ballast-heavers that it may ground level: should the pier not ground level it is raised by pumping out the water from the vacuities, or by means of machinery in the vessels, and the operation is performed until it grounds to the satisfaction of the architect.

Mr. Labelye in the erection of Westminster bridge, probably conceiving that he had improved upon this latter method, erected the piers of that structure in caissons or water-tight boxes; the bulk of the box producing a mass, though

* A cofferdam is a double inclosure of timber consisting of piles driven close together, and strengthened at intervals by larger piles and horizontal pieces: the space between the inclosures is filled with bricks and sand, or other materials, to serve the double purpose of giving weight to the dam, and excluding the water; and is an increased expense of about one-third of that of erecting the piers.

though loaded with the pier, specifically lighter than an equal bulk of water. After each pier was erected, the sides of the box served again for the boxes of the other piers: the pier was sunk and raised after the same manner as before described: there are not any piles under the piers of Westminster bridge; and only one of the foundations was found incapable of supporting its charge. Mr. Mylne, in the erection of Blackfriars bridge, adopted the same method as Mr. Labelye did at Westminster bridge in regard to the caissons: but he piled the foundations, and by a machine cut the piles off level with the bed of the river. In contemplating the conspicuous irregularities in the latter bridge, much advantage does not appear to have been gained by this extra expense, admitting the natural foundations to have been the same, which it is understood was the fact.

The practice adopted in the middle ages, probably from the time of St. Benezet the shepherd of Avignon, in the twelfth century, the first superior of the order of hospitallers called Pontifices, as at the bridges of Avignon, St. Esprit, Lyons, London, York, Newcastle, Rochester, &c. until modern times, was to drive piles in the bottom of the river in the site of the intended pier, and then to cut them off a little below low water: the interstices were then filled with stone and strong cement; upon the piles they laid a grating of timber boarded with thick boarding, which was the floor to receive the pier; the workmen taking advantage of the times of low water until the pier had risen to the level of high-water mark: this method is of the purest simplicity, nor does it require the aid of any machinery beyond a pile engine. The foundation of the piers of London bridge, as appeared from the pier which was taken down when the two small arches were converted into one, was formed of a quadruple row of piles driven close together on the exterior of the site of the pier, forming a case to receive the stone and cement: it was not ascertained whether there were piles in the heart of the pier; for as soon as the exterior piles were taken out, the great force of the water cleared away the remainder, which was driven down the river.

With a view to protect the piers of London bridge, there have been constructed round them what are called starlings: a starling is an inclosure of piles driven close together into the bed of the river, and tied together and secured by horizontal pieces of timber, and the space within them is filled with chalk, gravel and stone, so as to form a defence to the internal piles upon which the stone piers are erected.

It

It has been very improperly stated, that starlings are necessary to defend the piers when constructed after the manner last described: on the contrary, the use of starlings is not to defend piers of any particular construction; they have been used generally, when, by the plan of the bridge, too little waterway has been left; and are a very defective, extravagant and absurd remedy, tending to increase the evil the effects of which they are meant to oppose. The following table exhibits the proportion of the waterways at the three bridges in London.

	Area of the River.	Solids.	Waterway.
London Bridge . . .	19,586	11,581	8,005
Westminster ditto	19,010	4,242	14,768
Blackfriars . . ditto	19,083	4,001	15,082

Hence it appears that three-fifths of the water at London bridge is dammed up: the consequence has been, that the river at this part, by the increased velocity of the water, has had increased action on the bed, and it has been deepened 14 feet below its general surface, and the piers have been and are always subject to be undermined; while at the other bridges, where the waterway is duly proportioned to the quantity of the water, the bed of the river has remained stationary, and starlings or any other expedient have not been necessary to protect their piers.

It is manifest, upon whatever principle of construction the piers of London bridge might have been built, with the same proportion of solids to waterway, starlings, or some other means having a similar effect, must have been resorted to; and it may be inferred that, had the same proportion of waterway to solids been preserved, as in the other two bridges in London, there would have been inherent in it the same probability of duration; nor would there have been any more occasion to have recourse to starlings.

The method practised by the builders in the middle ages has got into great disrepute, from the prejudice in those times in favour of arcs of circles for the forms of their arches; and they were unable, or wanted courage, to erect arches of a great span, with a small versed sine: where the heights of the banks of rivers have permitted them to use an arc of a circle with an elevated versed sine for the form of the arch, they have exceeded both the ancients and moderns in the length of the chord.

The piers of their bridges were generally numerous, and their arches small, rendering an easy ascent to the passenger: an over anxiety for security induced them to make

 each

each pier wider than necessary: this surplusage, when multiplied, became as great an evil as that which it was intended to prevent. There is sufficient evidence to show, that timber always kept under water is imperishable, and that piles, if they are not undermined by an improper action on the bed of the river, have a stability superior to that of masonry; inasmuch as the masonry cannot have that connexion with the part buried in the soil, by which the stability of a structure subject to lateral pressure is in some measure obtained: it is true that the weight of masonry may be a substitute for the want of connexion: but that weight is obtained to a piled foundation after the manner of our ancestors by the stone-work with which they stuffed the interstices between the piles. It will be said that the piles are exposed to the corroding effects of friction from the passage of the water and the traffic: this is an old argument advanced periodically by the mason, and is best answered by those instances where this effect has been prevented by means not less simple than easy: it is an evil to which stone is equally liable, and it requires similar precautions.

There is an advantage in tidal rivers attached to the methods of the emperor Claudius and St. Benezet, which does not belong to the methods, by turning the water, by cofferdams and by caissons; namely, each pier and foundation, previously to the imposition of the arch, may be tried by loading it with a greater weight than the intended superstructure: a vessel of such a burthen may be floated over the site of the pier at high water, and left to rest on it when the water has ebbed.

In the first and second childhood of architecture, the same means are resorted to, to effect the works of art: tyranny in the one case, and wealth in the other, generally produce the same ends: in both states, great and solid works are produced, and the easy mode of obtaining them through a lavish expense of materials and labour naturally supersedes others which require less means and more talent and judgement: to these qualities in the middle state, when materials and labour are less at the command of the projector, there is a necessity of applying.

The method of laying piers of bridges dry by means of cofferdams was the method of early times, and is the method in practice at present. It is well adapted to a period when the labour and fortune of the subject are the unconditional property of the ruler, when means may be wanted to absorb the overflowing plunder of conquest, to paralyse the

the exertions of individuals in the employment of capital turned from its proper course, or to stem the torrent of improvident speculations by conspicuous objects of abortion.

London is not yet sufficiently wealthy for any projector, however venturous, seriously to propose the method of turning the course of the river Thames, in order to lay the foundation of a bridge. However great may be the commerce of the country, it has not been as profitable as the conquests of a Trajan: but the time may come, after having had recourse to the cofferdam, when his example of turning the Danube may be imitated in respect to the Thames. The emperor Claudius, although he was an idiot, seems to have been a very able architect: he erected perhaps the most magnificent temple, namely the Temple of Peace, left by the Romans: certainly there are in that structure the most scientific examples of vaulting remaining of ancient architecture. He also invented, or approved the invention by which the foundation of the port of Ostia was laid: whether he understood the art of making stone walls swim, remains in doubt. The invention of caissons or wooden boxes belongs to an age when both iron and stone had been made to float, and when that knowledge would seem to point out that caissons are altogether useless: at least the emperor Claudius would have discovered, after he had made stone piers swim by means of ropes, that there would not be any occasion for boxes of wood, when the pier itself by having some vacuities in it could be made to answer the same purpose.

It is due to those whose public virtue leads them to adorn the metropolis, and add to the advantages which so eminently belong to it, that their labours, disinterested as those labours must be where there has not been any rational hope of profit, should be attended with as little expense as possible: with that view the attention of your readers has been called to the different modes by which the foundations of the piers of bridges have been laid; that they may determine, according to the abilities which they may employ, whether they should adopt the expensive methods by turning the water into a new course, or by cofferdams,—methods of certain success under the management of ordinary abilities,—or whether they shall adopt the cheap methods of the emperor Claudius or St. Benezet, which require somewhat more talent and judgement.

LXI. *Further Remarks on the Rev. Mr.* Liston's *"Essay on perfect Intonation:" and his Scale with* 59 *Notes in the Octave; and on other Scales (perfect and tempered) for* 12, 14, 16, 17, 19, 21, 22, *and* 24 *Notes in the Octave respectively, &c. By Mr.* John Farey *Senior.*

To Mr. Tilloch.

Sir, In my last communication, respecting Mr. Liston's Euharmonic Organs at Flight's in St. Martin's Lane, two errors have escaped correction in p. 375, viz. line 9 from the bottom of the note, for 7T read 7L, and line 2 from bottom, after each, insert, ** and.

It is perhaps not generally understood, that the Douzeave or Scale of 12 notes, wherein the intervals above C are all diatonic, major and minor, has no sharpened notes, but all of the five interposed or chromatic notes, are *flats* (as I used to denote them, in my early papers in your Magazine), thus:

I 2 II 3 III 4 5 V 6 VI 7 VII VIII
C Db D Eb E F Gb G Ab A Bb B c
S 𝔖* S 𝔰* S S 𝔖 S 𝔰 S 𝔖 S
$\frac{1}{1}$ $\frac{15}{16}$ $\frac{8}{9}$ $\frac{5}{6}$ $\frac{4}{5}$ $\frac{3}{4}$ $\frac{45}{64}$ $\frac{2}{3}$ $\frac{5}{8}$ $\frac{3}{5}$ $\frac{9}{16}$ $\frac{8}{15}$ $\frac{1}{2}$
L l L l L L l L l L l L

The first of the above lines, marks the Intervals *major* and *minor*; the second, the letters or notes; the third, placed intermediary, show the intervals between the adjacent notes to be of three different values, viz. the *major* Semitone S, the *medius* Semitone 𝔖, and the *minor* Semitone 𝔰, the octave consisting of 7S + 3𝔖 + 2𝔰; and wherein it is easy, to count up any other intervals in S, 𝔖 and 𝔰 (which may be called the *Chromatic Elements*); thus, 2S + 𝔖 + 𝔰 is the Major Third, and 4 S + 2𝔖 + 𝔰 the Fifth, &c. The fourth line shows the ratios of the above Intervals in this chromatic scale; and the fifth shows by the letters L and l, placed intermediary, the major and minor Limmas, of a regularly *tempered scale;* in which it will be perceived, that in three instances the l or flat is substituted for 𝔖, and in two instances for 𝔰. Though the five flats would seem to indicate D, as the

* For the convenience of printing, I have taken the liberty of substituting the old English capital (𝔖) for the S with curved points for the Semitone medius = 47Σ + f + 4m in our 5th plate in vol. xxviii. and was so written in the copy; and the old English small (𝔰) for the scrip capital S or the Semitone minor = 36Σ + f + 3m in the Table, and in the copy.—Editor.

Key

Key major, in this case, yet it will appear, on counting up from D, that many of the intervals are false above that note, in this arrangement of the Douzeave.

Mr. Liston denominates that the *original Scale* (p. 28), which the twelve finger-keys give on his Organ, without the use of any pedal, viz.

I		II	3	III	4	IV	V		VI	7	VII	VIII
C	C✻	D	Eb	E	F	F✻	G	G✻	A	Bb	B	c
𝔖	S	S	𝔤	S	𝔖	S	𝔤	S	S	𝔖	S	
$\frac{1}{1}$	$\frac{128}{135}$	$\frac{8}{9}$	$\frac{5}{6}$	$\frac{4}{5}$	$\frac{3}{4}$	$\frac{32}{45}$	$\frac{2}{3}$	$\frac{16}{25}$	$\frac{3}{5}$	$\frac{9}{16}$	$\frac{8}{15}$	$\frac{1}{2}$
l	L	L	l	L	l	L	l	L	L	l	L	

Wherein, when compared with the last Scale, we have, instead of the minor Second in the first line, the redundant Unison; instead of the 5th we have the IV, and instead of the minor sixth the Redundant Fifth, or Diesis-defective minor Sixth. The second line shows, that three sharps and two flats occur in this original scale. The third shows the intervals between the several half notes, as they are vulgarly called, in Chromatic Elements, where 7S + 3𝔖 + 2 = VIII, as before; the fourth shows the ratios; and the fifth, the order of the two tempered douzeave Elements L and l mentioned in the note p. 375, and where 7L + 5l = VIII, as before.

The following Tables, will show the consonances that can be taken *true*, in the *Douzeaves* last mentioned, either Perfect or Tempered, and the Wolves or false notes which *result*, for the want of additional notes, beyond the number 12.

A Table of true Consonances.

Douzeave Consonances.	Perfect.	Regularly Tempered.	Douzeave Consonances.	Perfect.	Regularly Tempered.
✻I	𝔖	l	V	4S + 2𝔖 + 𝔤	4L + 3l
2	S	L	✻V	4S + 2𝔖 + 2𝔤	4L + 4l
II`	S + 𝔤	——	6	5S + 2𝔖 + 𝔤	5L + 3l
II	S + 𝔖	L + l	VI	5S + 2𝔖 + 2	5L + 4l
3	2S + 𝔖	2L + l	7`	6S + 𝔖 + 3	——
III	2S + 𝔖 + 𝔤	2L + 2l	7	6S + 2𝔖 + 2	6L + 4l
4	3S + 𝔖 + [illegible]	3L + 2l	VII	6S + 3𝔖 + 2	6L + 5l
IV	3S + 2𝔖 + 𝔤	3L + 3l	8	7S + 2𝔖 + 2	7L + 4l
5	4S + 𝔖 + 𝔤	4L + 2l	VIII	7S + 3𝔖 + 2	7L + 5l

A Table of Wolves, or resulting tempered Consonances.

Douzeave Consonances.	Bass and Treble Notes.	Wolf Intervals.
2	CC*, EbE, FF*, GG*, and BbB	l
II	C* Eb, and G* Bb	2L
3	Eb F*, FG*, and Bb c*	L + 2l
III	C* F, F* bb, G*c, and Beb	3L + l
4	Eb G*	2L + 3l
{ 5	CF*, DG*, EbA, FB, Gc*, and Beb	3L + 3l
{ IV	C*G, EBb, F*c, G*d, Aeb, and Bf	4L + 2l
V	G*eb	5L + 2l
6	CG*, EbB, Fc*, and Bbf*	4L + 4l
VI	C*Bb, F*eb, G*f	6L + 3l
7	Ebc*, and Bbg*	5L + 5l
VII	C*c, Eeb, F*f, G*g, and Bbb	7L + 4l

In the above Tables, where two consonances are linked together, only one of these can be tuned or taken on a douzeave Instrument, and they are only inserted here, for explaining the effects of different modes of tuning these notes, which so frequently require to be changed, in the taking of chords and in modulating. The 2nds in the first line in the last Table, are not in reality Wolves, because l is the proper value of a sharp or a flat, in Tempered Systems, but are inserted to show, that they differ from L the minor Second.

The *Quatorzeave* Scale of 14 Notes, on the Inner *Temple Organ*, effected by two divided finger-keys, is as follows; viz.

C C* D D* Eb E F F* G G* Ab A Bb B c
𝔖 S 𝔰† ε 𝔰 S 𝔖 S 𝔰 ε 𝔰 S 𝔖 S
l L l d l L l L l d l L l L

Here the Octave in perfect Intervals, consists of 5S + 3𝔖 + 4𝔰 + 2ε, as in the second line, and since 𝔰 + ε = S, this is equivalent to 7S + 3𝔖 + 2𝔰, as in the douzeave scale above. In the third line the elements of a regularly Tempered Scale on this Instrument are shown, the octave consisting of 5L + 7l + 2d; and since the minor Limma

† I am sorry to be obliged to substitute the small Greek epsilon (ε) for the scrip capital E, used for the Enharmonic *Diesis* 21Σ + 2m in the Table, Plate V in vol. xxviii. and in the copy.—Edit.

and

and Diesis make the major Limma in all such scales, or $l+d=L$; we have $7L+5l=$ VIII, as in the douzeave above.

The *Siezave* Scale of 16 Notes, on the *Foundling Hospital Organ,* effected by moving a stop sideways by the hand, is as follows; viz.

C C*Db D D*Eb E F F*G G*Ab A A*Bb B c
$\mathfrak{S}$ $\mathcal{E}$ $\mathfrak{S}$ $\mathfrak{s}$ ε $\mathfrak{s}$ S $\mathfrak{S}$ S $\mathfrak{s}$ ε $\mathfrak{s}$ $\mathfrak{S}$ $\mathcal{E}$ $\mathfrak{S}$ S
l d l l d l L l L l d l l d l L

Here the Octave in perfect Intervals, consists of $4S + 4\mathfrak{S} + 4\mathfrak{s} + 2\varepsilon + 2\mathcal{E}$; and since $\mathfrak{S} + \mathcal{E} = S$ and $\mathfrak{s} + \varepsilon = S$, this equation reduces to $7S + 3\mathfrak{S} + 2\mathfrak{s}$, as before. The regularly Tempered Octave in this case, consists of $3L + 9l + 4d$; and since $l + d = L$, this becomes $7L + 5l =$ VIII, as above.

The *Dixseptave* Scale of 17 Notes†, on the *Christchurch Organ,* in Surry Road, erected by Mr. Thomas Elliot, in May, 1812, under Mr. Hawke's Patent, effected by two Pedals; or, on the Piano Fortes now exhibiting by Mr. Bill, at No. 75, in Newman-street, is as follows, viz.

C C*Db D D*Eb E F F*Gb G G*Ab A A*Bb B c
$\mathfrak{S}$ $\mathcal{E}$ $\mathfrak{S}$ $\mathfrak{s}$ ε $\mathfrak{s}$ S $\mathfrak{S}$ $\mathcal{E}$ $\mathfrak{S}$ $\mathfrak{s}$ ε $\mathfrak{s}$ $\mathfrak{S}$ $\mathcal{E}$ $\mathfrak{S}$ S
l d l l d l L l d l l d l l d l L

Here the Octave in perfect Intervals, consists of $2S + 6\mathfrak{S} + 4\mathfrak{s} + 2\varepsilon + 3\mathcal{E}$; and which, since $3S = 3\mathfrak{S} + 3\mathcal{E}$, and $2S = 2\mathfrak{s} + 2\varepsilon$, becomes $7S + 3\mathfrak{S} + 2\mathfrak{s}$, as before. The regularly Tempered Intervals here are, $2L + 10l + 5d$ in the Octave; which, since $5L = 5l + 5d$, becomes $7L + 5l$ as before.

The *Dixneufave* Scale of 19 Notes, on an Organ which Mr. Russell senior, made about the year 1780 (see Dr. Kemp's Musical Magazine, vol. i. p. 170 and 188, and Mr. J. Marsh's Theory of Harmonics, p. 18), is as follows, viz.

C C*Db D D*Eb E E*F F*Gb G G*Ab A A*Bb Bcb c
$\mathfrak{S}$ $\mathcal{E}$ $\mathfrak{S}$ $\mathfrak{s}$ ε $\mathfrak{s}$ $\mathfrak{S}$ $\mathcal{E}$ $\mathfrak{S}$ $\mathcal{E}$ $\mathfrak{S}$ $\mathfrak{s}$ ε $\mathfrak{s}$ $\mathfrak{S}$ $\mathcal{E}$ $\mathfrak{S}$ $\mathcal{E}$ $\mathfrak{S}$
l d l l d l l d l d l l d l l d l d l

Here $8\mathfrak{S} + 4\mathfrak{s} + 2\varepsilon + 5\mathcal{E} =$ VIII; and since $5S = 5\mathfrak{S} + 5\mathcal{E}$, and $2S = 2\mathfrak{s} + 2\varepsilon$, we have $7S + 3\mathfrak{S} + 2\mathfrak{s}$, as before. Also $12l + 7d =$ VIII, and since $7L = 7l + 7d$, we have $7L + 5l$, as before.

† Mr. Kirkman is said to have made Instruments with 17 notes, before the year 1790, see Dr. Kemp's Musical Magazine, vol. i. p. 134; and the late Mr. Charles Claggct also did the same.

The

The *Vingtunave* Scale of 21 Notes, on Dr. Robert Smith's Harpsichords, made by Mr. Kirkman about the year 1758, effected by moving 6 stops sideways by the hands, (see Dr. Smith's "Harmonics," 2nd Edit. p. 186,) is as follows, viz.

C C*Db D D*Eb E Fb E*F F*Gb G G*Ab A
$\mathfrak{S}$ $\mathfrak{E}$ $\mathfrak{S}$ $\mathfrak{s}$ ε $\mathfrak{s}$ ε δ $\mathfrak{E}$ $\mathfrak{S}$ $\mathfrak{E}$ $\mathfrak{S}$ $\mathfrak{s}$ ε $\mathfrak{s}$ $\mathfrak{S}$
l d l l d l d $\mathfrak{d}$ d l d l l d l l

A*Bb B cb B*c
$\mathfrak{E}$ $\mathfrak{S}$ $\mathfrak{E}$ δ ε
d l d $\mathfrak{d}$ d

Here $6\mathfrak{S} + 4\mathfrak{s} + 2\delta + 4\varepsilon + 5\mathfrak{E} = \mathrm{VIII}$, and since $3S = 3\mathfrak{S} + 3\mathfrak{E}$, $2S = 2\mathfrak{s} + 2\varepsilon$, and $2S = 2\delta + 2\varepsilon + 2\mathfrak{E}$, the above equation reduces to $7S + 3\mathfrak{S} + 2\mathfrak{s} = \mathrm{VIII}$, as before. Also, $10l + 9d + 2\mathfrak{d} = \mathrm{VIII}$, and since $d + \mathfrak{d} = l$ we have $12l = 7d$, as for the 19 Notes above; or, since $l + d = L$, we have $7L + 5l = \mathrm{VIII}$ for 12 Notes, as before.

The *Vingtduxave* Scale of 22 Notes, on the *Teliochordan Harpsichord* in the Royal Library at Buckingham-House, made by Mr. Charles Clagget in 1790, effected by two Pedals, acting on movable Bridges, is as follows, viz.

C C*Db D D*Eb E Fb E*F F*Gb F**G
$\mathfrak{S}$ $\mathfrak{E}$ $\mathfrak{S}$ $\mathfrak{s}$ ε $\mathfrak{s}$ ε δ $\mathfrak{E}$ $\mathfrak{S}$ $\mathfrak{E}$ δ ε $\mathfrak{s}$
l d l l d l d $\mathfrak{d}$ d l d $\mathfrak{d}$ d l

G*Ab A A*Bb B cb B*c
ε $\mathfrak{s}$ $\mathfrak{S}$ $\mathfrak{E}$ $\mathfrak{S}$ $\mathfrak{E}$ δ ε
d l l d l d $\mathfrak{d}$ d

Here $5\mathfrak{S} + 4\mathfrak{s} + 3\delta + 5\varepsilon + 5\mathfrak{E} = \mathrm{VIII}$, and since $2S = 2\mathfrak{S} + 2\mathfrak{E}$, $2S = 2\mathfrak{s} + 2\varepsilon$, and $3S = 3\delta + 3\varepsilon + 3\mathfrak{E}$, we have $7S + 3\mathfrak{S} + 2\mathfrak{s}$, as before. Also, $9l + 10d + 3\mathfrak{d} = \mathrm{VIII}$, and since $4L = 4l + 4d$; and $3L = 6d + 3\mathfrak{d}$, we have $7L + 5l = \mathrm{VIII}$, as in the Douzeave.

The *Vingtquatreave* Scale of 24 Notes, on the Patent *Harmonic Piano Forte* and *Organ* invented by Mr. David Loeschman in 1809, now exhibiting at his house, No. 82, Newman-street, effected by six Pedals, is as follows, viz.

C C*Db C**D D*Eb E Fb E*F F*Gb F**G
$\mathfrak{S}$ $\mathfrak{E}$ δ ε $\mathfrak{s}$ ε $\mathfrak{s}$ ε δ $\mathfrak{E}$ $\mathfrak{S}$ $\mathfrak{E}$ δ ε $\mathfrak{s}$
l d $\mathfrak{d}$ d l d l d $\mathfrak{d}$ d l d $\mathfrak{d}$ d l

G*Ab

G*	Ab	A	Bbb	A*	Bb	B	cb	B*	c
	ε	ʒ	ε	δ	Є	ℨ	Є	δ	ε
	d	l	d	ɗ	d	l	d	ɗ	d

Here 3ℨ + 4ʒ + 5δ + 7ε + 5Є = VIII, and since 2S = 2ʒ + 2ε, and 5S = 5δ + 5ε + 5Є, we have 7S + 3ℨ + 2ʒ = VIII, as before. Also, 7l + 12d + 5ɗ = VIII, and since 2L = 2l + 2d, and 5L = 10d + 5ɗ, we have 7L + 5l = VIII, as before.

The *Cinquanteneufave* Scale of 59 Notes, on the Patent *Euharmonic Organ* invented by the Rev. Henry Liston, in 1810, and made by Messrs. Flight and Robson, in 1812, now exhibiting at their house, No. 101, in St. Martin's Lane, effected by 11 Pedals, is as follows, viz.

C	C′	C‵*	C*	Db	C′*	D′b	C**	D‵	C′**	D	D′
c	ꞇ	c	Є	Σ	Є	π	Є	Σ	Є	c	ꞇ
0	11	36	47	57	58	68	83	93	94	104	115

D*	E‵b	D′*	E‵b	E′b	E	F‵b	E′	Fb	F′b	E‵*
Є	Σ	Є	c	ꞇ	Є	Σ	Є	c	ꞇ†	c
140	150	151	161	172	197	207	208	218	229	233

E*	F	E′*	F′	F‵*	F*	Gb	F′*	G′b	F**
Є	Σ	Є	ꞇ	c	Є	Σ	Є	π	Є
244	254	255	265	290	301	311	312	322	337

G‵	F′**	G	G′	G*	A‵b	G′*	Ab	A′b	A
Σ	Є	c	ꞇ	Є	Σ	Є	c	ꞇ	c
347	348	358	369	394	404	405	415	426	451

A′	Bbb	B′bb	A‵*	A*	Bb	A′*	B′*	B‵	B
Є	c	ꞇ	c	Є	Σ	Є	ꞇ	c	Є
462	472	483	487	498	508	509	519	544	555

Cb	B′	Cb	B*	c‵	B′*	c
Σ	Є	π	Є	Σ	Є	
565	566	576	591	601	602	612

Here 7ꞇ + 3π + 13c + 23Є + 2ꞇ + 11Σ = VIII, and because 5ꞇ + 6Є + 11Σ = 3π + 13c + 2ꞇ, the above equation becomes 12ꞇ + 29Є + 22Σ, as in the Table of Intervals at page 276 of vol. xxxvii; and also, since 7S = 7ꞇ + 21Є + 14Σ, 3ℨ = 3π + 9c − 3Σ, and 2ʒ = 4c + 2Є + 2ꞇ, we have 7S + 3ℨ + 2ʒ = VIII, as above. In the third line, the number of schismas or Σs, answering (in my Notation) to each of Mr. Liston's Notes, are given; these, by some have

† I am obliged to substitute the old English small c (ꞇ) for the ſc with a dash across them, used for the semi-comma major 4Σ + f in vol. xxviii. Plate V, and in the copy.—Editor.

have been called my *Artificial Commas*, in imitation of Mercator's artificial commas 53 in the Octave, (Holder's Treatise, 1st Edit. p. 79), the reason or derivation of whose curious approximate common-measure to Intervals, was unknown, I believe, until I had expressed and arranged Intervals in the notation by Σ, f and m, when the number of ms to any note in such new Notation, was found to agree exactly with Mercator's numbers. With respect to these and all other *artificial commas*, it is to be observed, that they form a sort of musical (whole number) logarithms, having the least Interval as their *unit*, and will, by addition and subtraction, correctly show the values and relations of intervals *larger than their unit, and between which no differences occur smaller than their unit;* all smaller intervals, and some of those very near to the value of the unit, are however erroneously expressed by them: but in perfect Harmony, as I have before observed (vol. xxxvii. p. 274), no less Interval than Σ occurs, and therefore they may be safely used, in all its calculations.

In the Table which I gave in vol. xxxvii. p. 276, of the Notes on Mr. Liston's former Instrument, nine of the above notes are omitted, viz.

	f	m	Σ		f	m	Σ
B′bb	9	24	18	Fb	4	11	8
Bbb	9	23	17	F\`b	4	10	7
F′**	7	16	13	C′**	2	4	4
F**	7	15	12	C**	2	2	2
F′b	4	12	9				

And the 10 following were inserted unnecessarily in that Table, on account of there being no shades to produce these notes, as being found unnecessary in the widest range of modulation; viz. B\`*, C\`b, B\`b, A\`, G\`*, G\`b, F\`, E\`, D\`* and D\`b, by which the scale for the new Organ is reduced to 59 Notes, as above.

The shades by which the alteration of a comma is produced in the sounds of the Pipes, as explained in vol. xxxvii. p. 328, and in Mr. Liston's Essay, p. 45, not being able to *raise* their sounds, only to depress their pitch, one, or two commas, the Pipes in Mr. L.'s Organ, are necessarily tuned to the acute notes; a standard Pipe, a major comma higher than Concert Pitch, being used for pitching C′ †, from whence the Tuning is conducted *upwards*, thus, viz.

† Or, having the pitch of C, we may tune upwards C $_{\mathrm{V}}$ G $_{\mathrm{V}}$ D $_{\mathrm{V}}$ A′ $_{\mathrm{V}}$ E′, and then downwards F′ $_{\mathrm{III}}$ C′ which is the proper pitch for commencing Tuning, as Mr. L. shows, p. 44.

C′

$C' {}_{V} G' {}_{V} D'$: then $C' {}_{III} E' {}_{V} B' {}_{V} F'* {}_{V} C'*$, and $E' {}_{4th} A'$; then $E' {}_{III} G'* {}_{V} D'* {}_{V} A'* {}_{V} E'*$; then $G'* {}_{III} B'* {}_{V} F'** {}_{V}, C'**$.

Then *downwards* $C' {}_{V} F' {}_{V} B'b$; then $C' {}_{III} A'b {}_{4th} E'b$: then $A'b {}_{V} D'b {}_{V} G'b {}_{V} C'b$; and then $A'b {}_{III} F'b {}_{V} B'bb$; which completes the Tuning of *the Pipes.*

Three Fifths are then tuned *downwards* by help of the one-comma shades to obtain C, viz. $A' {}_{V} D {}_{V} G {}_{V} C$. Then $C {}_{III} E {}_{V} B {}_{V} F*$, &c. just as above, except being a comma lower, or without acute accents.

In like manner three other Fifths are tuned *downwards*, by means of the two-comma shades, to obtain $C^{\backprime}$, viz. $A {}_{V} D^{\backprime} {}_{V} G^{\backprime} {}_{V} C^{\backprime}$. Then *upwards* $G^{\backprime} {}_{III} B^{\backprime}$; then $D^{\backprime} {}_{III} F^{\backprime}* {}_{III} A^{\backprime}*$: and then $A {}_{III} C^{\backprime}* {}_{III} E^{\backprime}*$. Then *downwards* $C^{\backprime} {}_{III} A^{\backprime}b$; then $G^{\backprime} {}_{III} E^{\backprime}b$; and then $Cb {}_{V} F^{\backprime}b$. Which completes the tuning of the 59 Notes of this *Grand harmonic Scale;* at the multiplicity of whose Notes, the intelligent student need not be at all alarmed, since the excellent contrivance of Mr. Liston's Organ, enables the whole to come into play when wanted, through the means of the 12 ordinary finger-keys, and a pedal to be pressed now and then, when the key changes, so as to require the use of notes beyond those twelve that are in the scale at the time; and at others, when certain notes require altering a comma to perfect the harmony, all of which are marked in numerous examples and pieces of music, in Mr. Liston's Book, and in other printed Music that he has ready provided, for those Professors or Amateurs who may honour him by a trial of his Instruments, at Messrs. Flight and Robson's.

The commendable disposition shown by the people of this metropolis, for encouraging an extension and improvement of the Musical Scale of *Keyed Instruments* (for with Voices and Violins, &c. Mr. Liston's scale always has and always will be *in use*), in the instances that I have mentioned above, seems in a particular manner to have alarmed the German Organist Mr. Kollmann, for the fate of his modern

modern "scale of nature," or 12 sounds only in the Octave, placed at equal distances, on which his "new Theory" appears entirely built, that he so pompously and incessantly compares with the best writings of British Musicians, to their disadvantage, in his Quarterly Review; which "*wonderful* compound of *twelve* Diatonic Chromatic Enharmonic Scales *in one!*", it is admitted by Mr. K. must be abolished, as the first consequence of the establishment of the "artificial *Temperaments*" of Hawkes, Loeschman, and *Liston!*, and therefore, he takes especial pains to cry them all down as useless and absurd.

What a lamentable case! that the progress of Science and Improvement in one of the most delightful of arts, should render the sale less certain, of the voluminous works of this profound Theorist!, who, to the honour, or disgrace rather of the age, broadly asserts, that violins, violoncellos, and voices, *ought not* to make *any difference* between A♭ and G*, D♭ and C*, &c.!!, but should use, "as nearly *equal* a *temperament* † as possible," or in other words, "follow the (his) true *standard scale*, on which all modern music depends." Not doubting but the scientific and demonstrable principles advanced in the "Essay on perfect Intonation," will make their way, confirmed as they are in every case, by an appeal to experiment, unimpeded by such antiquated and unphilosophical, not to say interested, opposition, as that I have been alluding to,

I remain, sir,

Your obliged and very humble servant,

12, Upper Crown-Street, Westminster,
June 4, 1812.

JOHN FAREY Sen.

P. S. In conversation a few days ago with Mr. Loesch-

† A Temperament as nearly *equal* as it is possible for the ear to judge of it, results from taking each Fifth a schisma flat, or making the same to consist of 2t + 3H, as first mentioned in your 28th volume, p. 65 (see also xxxvi. p. 48). Now, in Mr. Liston's Scale above described, there are 15 pairs of notes exactly at this distance apart, viz. C* & A`b, C'* & A♭, C'** & A, D' & B♭♭, D'* & B♭, E' & C♭, E* & c`, E'* & c, F'* & d♭, F'** & d`, G'* & e`b, A' & f`b, A'* & f, B' & g♭, and B'* g`. And 15 pairs of equal temperament Fourths, the complements of the above, as A`b & C*, A♭ & C'*, &c. whose value is 3T − H or 255Σ + 5f + 22m.

Twenty-six major Thirds and as many minor Sixths are found in his scale that differ only 3Σ from the equal Temperament, and 24 minor Thirds and as many major Sixths that differ only 2Σ from these favourite chords of Mr. Kollmann, but no concords except I, VIII, V and 4, that exactly agree with that Scale. I am not aware, how far the construction of Mr. L.'s new Organ, admits of trying the notes together, of the above equal temperament Scale.

man,

man, he informed me, that he could introduce this extended scale of 59 *Notes on a Grand Piano Forte;* using movable bridges, for producing the sharpening of one or of two commas, of an improved construction, that for such small alterations, would be free of the evils formerly produced by Mr. Clagget's movable bridges, for changing sharps to flats, &c.; but he has no inclination to embark in such a speculation, unless some Nobleman or Gentleman would *order such an Instrument.* Mr. Liston informs me, that this was one of the first applications of his principles, that occurred to him; but that on application to Mr. Stoddard, he dissuaded him from thinking of applying them, on any Instrument but the Organ.

LXII. *On Vegetable Wax, &c. By* R. MAC-CULLOCH, *M.D. Woolwich. Communicated by the Author.*

It is now well known that wax is a vegetable product, as well as the result of an animal process in bees and other insects, and the wax of various plants has been successively examined by different chemists. Some slight differences have been observed in the several varieties, but they are not sufficient to lead us to consider them as different species; rather, like the generality of the resins, to be varieties of one common substance. To those already described there is still to be added one, which as far as I know has not yet been noticed. This is a substance held in solution in the essential oil of the rose (the attar of roses) and in that of lavender. I have not searched among the other oils, but it will probably be found in some of them. All the varieties of these two oils do not however contain it; it is frequently absent in the oil of lavender, although but rarely in that of the rose.

I am not acquainted with the circumstances under which this variation occurs. When these oils are cooled below a certain point, a portion of this matter is deposited in the form of minute crystals, giving them an appearance somewhat similar to that which the fixed oils assume on freezing. On the addition also of alcohol it is separated in the form of minute brilliant scales, and by this method I obtained the portion which I examined. It is equally separated by water, which, if enough be used, dissolves the whole of the oil, and leaves it in a pure state. It is thus that it is collected in the pipes of the stills in which rose-water is made, as it is volatilized in combination with the oil, and precipitated

tated by the action of the water which is condensed in the worm. That with which I made the following experiments was procured from lavender; but it seemed to differ in no respect from that which I have procured from the oriental attar of roses, or from the distillation of rose-water.

Although I have called it wax in consideration of its vegetable origin, it bears in fact a much nearer resemblance to spermaceti in its general properties. Like that, its feel is greasy, and it is deposited in a crystallized mass at the bottom of the vessel, just as that substance is deposited from the oil of the Cachalot whale.

The few comparative experiments which follow, will show its nature more completely. Having but a very small quantity, I could not conveniently determine its specific gravity; but it is much lighter than either wax or spermaceti, since it swims in sulphuric ether. It crystallizes from its solutions in resplendent scales, and in this property it approaches rather to spermaceti than wax. Its colour is white, and its texture flaky. It is fusible at 96°, while wax is only fusible at 120°, and spermaceti at 102°. This account of the fusibilities of wax and spermaceti differing from that commonly received, which states them at 142° and 133° respectively, it is necessary to say that the mode which I took to determine this temperature, and to which I was compelled by the scantiness of my materials, was by causing them to melt on hot water in which a thermometer was immersed, and noting the heat at the moment of congelation. In boiling alcohol it dissolves readily and in as large proportion as spermaceti, more readily and in larger proportion than wax; and it is deposited again on cooling. The three substances seemed equally soluble in boiling ether, which however dissolves less of them than alcohol does. Its habits with the other compound inflammables, and with the alkalies, resemble those of wax and spermaceti, and afford no distinction.

It is volatilized without apparent change in a temperature considerably lower than spermaceti, and I need not add, that its vapour is equally inflammable. I had no adipocire with which to compare it.

Considering these circumstances, we may perhaps regard it as a vegetable concrete oil, resembling spermaceti rather than wax, yet differing from it in the characteristic circumstances of superior volatility and inferior specific gravity, and bearing a relation to essential oils similar to that which spermaceti does to the fat ones.

LXIII. *On*

LXIII. *Correction of an erroneous Statement in the Account of Mr.* Bakewell's *Lectures, as to his Originality in exhibiting a Geological Map of England: with Remarks on the Geological Questions, Whether the lower Derbyshire Strata anywhere else appear in England?; Were Caverns formed by subterranean Currents of Water?; and, How were Mineral Veins opened and filled?. By Mr.* John Farey *Senior.*

To Mr. Tilloch.

Sir, When I first read in your account of Mr. Robert Bakewell's Lectures, at the Russell Institution, p. 234, of your March Magazine, that Mr. B. exhibited to his auditors, "a Geological Map of England, drawn for the purpose" of his Lectures, and said, "that, so far as he knew, *this was the first attempt* to represent in a Map the geological outlines of England," I supposed this statement, of a claim to originality in mineral Maps of England, to be made, by an error or misconception of your Reporter, and which from its manifest *injustice to others*, would receive a speedy correction from Mr. Bakewell, or some of those who attended his Lectures: after waiting, however, the conclusion of his three courses, without seeing anything further on the subject, I am induced to request your permission to point out, that it is incredible that Mr. B. should have been uninformed, that Mr. *William Smith* of Buckingham-street, had nearly completed such a Map years ago, as very often has been mentioned in your Magazine*, in Dr. Rees's Cyclopædia, &c.; not to mention a work, to which Mr. B. himself refers (at p. 236), my Derbyshire Report, vol. i. p. 108; nor is it more likely, that Mr. B. was uninformed, that a primary object of the Geological Society of London, as expressed in their printed "Geological Inquiries," was to prepare "Mineral Maps of districts," or that he was altogether ignorant of the progress, that G. B. Greenough, Esq. their very able and indefatigable president had made, in a Map of England and Wales, and another of Scotland, which have been very liberally shown (as his important collection corresponding to them has) to great numbers, besides the members of the Society assembled at their meetings; which last Maps, from combining, all that had been learnt from Mr. Smith, either directly or through me, or others who have examined his Maps and collection, with

* Particularly in volume xxxv. p. 114.

the

the extensive and systematic observations of Mr. G. himself, and the more local observations of others on the British strata, and with most of what has been from time to time published on the British strata, and on the unstratified districts of Cornwall, the central and northern parts of Wales, the Malvern Hills, Charnwood Forest, parts of Westmoreland, Cumberland, and Northumberland, &c. and of great part of Scotland (with which last districts Mr. Smith had not much concerned himself), are, doubtless, much more extensive and correct, than anything that Mr. B. would be able to produce, or at least, to which he could justly lay claim, without acknowledgement of the sources whence he derived part at least of his materials. I was, therefore, and still am desirous, sir, of thinking, that Mr. B. only intended to say, that this was the first time that a Geological Map of England had been exhibited in a course of *public Lectures* expressly on the subject; which yet, if it be literally true, will scarcely render this claim of Mr. B. a fair one, as it is stated, when it is considered, that Mr. Greenough's Maps have, often I believe, been exhibited to geological assemblies of persons, and that Mr. Smith's were more than once, I believe, exhibited to numerous meetings of the Board of Agriculture, and have so often been shown publicly, at meetings congenial with Mr. B.'s previous pursuits in life*, at Bath, Woburn, Holkham, Goswell-street, &c. as I have mentioned in your xxxvth vol. p. 114, and elsewhere. Let it not be supposed, that I am herein laying any claim to a Geological Map of England of my own, since it is well known to my friends, that the obligations which I have felt myself under to *Mr. Smith*, as *the original practiser and promoter of useful and general investigations of the Strata*, have, as much as the want of time for it, prevented my attempting any general Map, such as those of Mr. Smith and Mr. Greenough above mentioned: while at the same time, I have never been backward, in the very frequent interviews with which I have been honoured by the latter gentleman, to communicate or contribute any thing within my knowledge, towards the perfecting of his Map, always relying, as I do, that no publication of it will ever take place, without at the same time, rendering ample acknowledgements to Mr. Smith, from whose useful labours the ground-work, and much of the materials in the superstructure have been obtained.

While I am upon the subject of Mr. Bakewell's Lectures,

* I allude here, to his investigations and work on *Wool*.

or

or rather the account of them that you have published, permit me to mention, that I still with additional reason, as I conceive, adhere to my former position, in the Derby Report, &c. with respect to the metalo-basaltic Limestone Rocks of Derbyshire, having *lower places in the series* than any other Rocks that I have seen, or know by the Reports of others, in the British Islands; and still conclude, as I mentioned in your 102d page (vol. xxxix.), that the same do not appear in the north-west of Yorkshire, in particular, as Mr. Bakewell is made to assert, p. 236; since on inquiry, I am told, that his reasons for so saying are, that "the *quality* of the Limestone and the Mineral Veins are the same," which I hold to be very inadequate marks of the identity of strata: surely Mr. B. might have done, or can now tell us, whether the *succession* upwards, from what he calls the 4th Limestone, is the same, or at all allied, to that I have described in Derbyshire? but above all, whether he was able to detect, all or any considerable proportion of the species of sheils and other *Reliquia* in the Yorkshire Limestones, that the late Mr. William Martin has figured and described in his "Petrificata Derbiensia"? Shropshire or North Wales, I have not seen, except in the distant horizon, but from what I have read of Mr. Arthur Aikin's on those districts, and learnt from my valuable friend Mr. John Lloyd, of Wygfair, (who descended into Elden Hole, many years ago,) and others, I conclude the limestone Rocks there, to be the same with that which underlies the great South Wales Coal-bason, of which I have made mention in the preface to my Report, p. xiii, and which overlies a *Red-Marl* series, such as I have described at p. 270, in your 39th volume, but not the same probably.

That the *Caverns* in Limestone Rocks, were not generally formed by the washing of subterranean currents, at least, are not now enlarging or deepening by that means (as I hear that Mr. B. maintains respecting certain Caves in or near Cumberland), must be abundantly evident, to those who will examine the bottoms of such Derbyshire caverns or opens, as are connected together, and which will be found in great part filled up with mud, sand, shale-grit and quartz gravel, &c., washed into them from the surface of the shale, by means of some of the Water-swallows that I have mentioned, Rep. i. p. 295: Merlin's Cave, in the Land occupied by the late William Langsdon, Esq. (but as I am told, not belonging to him, as I have stated) and now

 by

by Mr. Thomas Bird, I believe, in Eyam, is a very complete instance of this filling up of caverns by subterranean currents, instead of their being formed thereby.

Respecting the opening of the fissures occupied by *mineral veins*, Mr. B. (p. 314) appears, like Dr. James Miller, when speaking of the Wernerian Theory (as I have observed in the note, p. 74 of my Report) to overlook the causes assigned, and principally insisted on by M. Werner himself, in his "new Theory" of Veins, lately translated, viz. *slips* "in rainy seasons," and the yielding and cracking of the mass by its own weight, when the rock was "at first wet and possessed little solidity," and part of it fell to the free side!. The suggestions which Mr. Bakewell offers, at the bottom of page 315, as to the probable voltaic influence which the sides or cheeks of the Vein have had on the metallic deposits within it, is ingenious, and accords well with most of the facts which I know, particularly that remarkable one, that the bearing measures (Rep. i. 246), or particular beds of Rock between which the ore is principally lodged in the vein, were in several of the most productive Mines in Derbyshire, *considerably inclined to the horizon*, and are so in the Gang and some others, that are yet working: indeed, where the Limestone laps round an irregular lump of Toadstone in the floor of the Rock, as in Ashover Velley, Crich, Matlock High-Tor and Masson Hills, &c., the bearing-measures therein, are found to conform to this shape of the floor, with very various and sometimes sudden changes in their inclination to the horizon: and furnish a good proof, in accordance with every other ascertained fact, that these Limestone Rocks could not have been *bent* into their present form by injected Lava between them, as Mr. B. appears, I think, disposed to concede to Mr. Whitehurst: since few persons would grant, that the *crystals* of spar and ore in a vein could have been *soft* and capable of bending, without the least fracture or distortion being observable in them; whatever a superficial knowledge of stony *depositions*, might dispose them to concede, with respect to the rocks that contain the veins.

I am, sir,

Your obedient servant,

Westminster, June 14, 1812. JOHN FAREY Senior.

LXIV. *On*

LXIV. *On the Effects produced by the Use of the Oxymuriates of Lime and Magnesia in Bleaching.* By Mr. William Moore.

To Mr. Tilloch.

Sir, In the proceedings of the Kirwanian Society of Dublin, published in your Magazine for last month, Dr. Ogilby having stated some assertions he said were made by Professor Davy, as to the theory and effects of oxymuriate of lime in bleaching; as I have been present at the lectures when those assertions are said to have been made, I am confident Dr. O.'s statements are incorrect; I therefore trouble you with the following narration of facts:

Sir Humphry Davy, having stated that muriate of lime had been *proved by experiments* to have a deleterious effect on linen cloths, recommended the use of oxymuriate of magnesia for that of lime in bleaching. His reasoning as to the muriate of lime was, "that bodies in their nascent state acted with more energy than when they had been formed; and not as Dr. Ogilby says, that "if a strong solution of muriate of lime rendered cloth unsound, a weak one ought to be proportionally detrimental." The Doctor's experiments to prove that muriate of lime had not an injurious action on linen cloths, I have repeated, viz. having steeped cuttings of full bleached linen in solutions of the neutral salt of different degrees of strength, some nearly saturated: they were steeped* only for twenty-four hours; and upon being well washed and dried, they were found to be so rotten as not to require any longer trial. The repetition of Dr. Ogilby's experiments was "deemed worthy," not from an idea "that Sir Humphry Davy's views on this subject *were all together erroneous*," as the Doctor *modestly* asserts, but from a presumption that the Doctor *might possibly* be mistaken.

Dr. Ogilby also contradicts an assertion which *he says* Sir Humphry Davy made; namely, "that magnesia had entirely superseded the use of lime in Ireland for bleaching;" and the Doctor says, that not a single bleacher uses it. To refute this, I need only state (as nearly as possible) the words made use of by the Professor in the lectures. He said that he was happy to state that some hints which he had the pleasure to give in a preceding course of

* The Doctor repeated the immersions four times, for twenty-four hours each time.

lectures had been acted upon by an enlightened *individual*, Mr. J. Duppy junior *, of Dublin, who had tried magnesia instead of lime; and that it succeeded to his wishes. As Dr. Ogilby was present at the lectures in Dublin, I am at a loss to account for his mis-statements. Unwilling to attribute them to any improper motive, I conclude that they were made in ignorance of the *facts*.

I remain, with respect, sir, your obliged,

London, June 12, 1812. WILLIAM MOORE.

LXV. *Method of preparing a cheap and durable Stucco, or Plaster, for outside or inside Walls. By* H. B. WAY, *Esq. of Bridport Harbour* †.

SIR, IN consequence of your expressing an opinion that a general knowledge of my method for preparing a stucco, or plaster, for outside walls of houses much exposed to sea breezes or bad weather, would be of service to the public, I have inclosed an account of the process, and I will with pleasure furnish any further particulars of this business for the Society of Arts, or permit any gentleman to examine it who may wish for more information on the subject. You know the situation of my house, which is greatly exposed to the spray of the sea and bad weather; and I can truly add, that by means of this stucco it is perfectly free from damp, and the plaster remains compact and durable.

I remain, sir,

Your obedient humble servant,

Bridport Harbour, Oct. 12, 1810. H. B. WAY.

To C. Taylor, M.D. Sec.

To make a strong Stucco, or Mortar.

Three parts Bridport Harbour-sand to one of lime, both finely sifted, and mixed with lime-water; if used as stucco, the first coat to be laid on half the thickness of a crown-piece; let it remain two days, then with a painter's brush

* The Professor showed the letter to this effect from Mr. Duppy, which he had received that morning, as also some pieces of calico goods which had been bleached by the magnesian process; and Mr. Duppy also thought the colours were superior in brilliancy to those prepared by lime, as the former process directed.

† From *Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce*, for 1811.——The silver medal of the Society was voted to Mr. Way for this communication, and specimens of the Stucco and of the Sand are preserved in the Society's Repository.

wash

wash it over with strong lime-water, and lay on the second coat of the same thickness.

1805, March 25.—Measured a coal half-bushel of Beamister lime, and put it into a hogshead of water, to make the lime-water.—Measured two coal half-bushels more of the lime, slacked and sifted it, it then measured three half-bushels, to which were added nine coal half bushels of Bridport Harbour-sand well sifted; I saw it well mixed up with lime-water, and thoroughly worked together; the next day saw it turned, and again mixed up, that it might be well incorporated together.

27th.—This morning had a fine coat of it laid on the west end of my large storehouse at Bridport Harbour.

29th.—Had it washed with lime-water, and a second coat laid on.

Cost.	*s.*	*d.*
One sack and a quarter of lime, at 2*s.* 6*d.*........	3	$1\frac{1}{2}$
Two men and one boy two days each, fetching and mixing up materials, and laying on; men 2*s.* 3*d.* per day, boy 10*d.* per day, and one pint of ale each per day, 12*d.*........................	11	$10\frac{1}{2}$
	15	0

N. B.—I suppose the expense rather over than underrated.

May 11.—This day Thomas Everett measured and examined the work, found it hard and sound, $24\frac{7}{9}$ square yards, a little done to the house, suppose the whole to be twenty-five yards square.

Twenty-five square yards at $7\frac{1}{4}$*d.* per square yard, would be 15*s.* $1\frac{1}{4}$*d.*

June 13, 1806.—Examined the work, which was perfectly sound and free from cracks, nothing having ever peeled off from it. The situation exposed to the weather in the greatest degree.

N. B.—The coal half-bushel above mentioned holds exactly thirteen gallons wine-measure.

H. B. Way.

Sir,—I was favoured with yours of the 18th instant, and I now inclose the mason's certificate of the quantity of stucco done with the composition I gave him the particulars of, in addition to which it may be necessary to mention that the coal half-bushel, with which the ingredients of the

composition were measured, (according to the account formerly given,) contains exactly thirteen gallons of water, wine measure, and would hold exactly 1 cwt. 1 qr. 7 lb. net of the sand used; the weight of the lime I do not know, and my being able to ascertain exactly the weight of the sand, arose from my waggon being employed to carry what was used at Yeovil and East Coker, from hence, and for what I sent to Yeovil I was paid 1*s*. 9*d*. per cwt. From the sand here succeeding so well, Thomas Everett would not be prevailed on to engage to do any of that sort of work with hill or river sand, to be got on this shore. The work he did for me was all by the day; what he did at Yeovil and East Coker he agreed for at eight-pence per yard, of nine feet superficial measure for labour only for the two coats, at four-pence per square yard for one coat, all the materials being brought to the spot at his employer's expense, and who also found scaffolding and scaffold ropes: this, I think, is considerably higher than by my calculation of the expense of what I had first done he ought to have charged; but its being done at a distance of twenty miles from where he lives, and in the most busy time of the year for mason's work, I suppose must account for it in the first instance, and having once made that price, he would not now work under; but I believe, for a considerable building, and with sufficient notice, and being allowed 6*d*. per mile in lieu of wages and travelling expenses for himself and an assistant, out and home, he would go to any part of the kingdom, on being paid 8*d*. per yard for the work. It has been the general received opinion here, that plaster made with sea sand, unless well washed in fresh water, would be always damp; but, on the contrary, I find from what has been done in my dining-parlour and passage, it has been always quite dry, although the whole of the sand with which it has been done has been thrown up by the sea, and must have been always at spring tides covered with sea water; indeed, it sometimes happens that, for months together, there is none to be collected on our shores at this place, that Everett thinks fine enough for the purpose; and as I am now and then applied to for getting it, I have lately, when my horses were at leisure, got a small quantity collected and hauled in for my own use, or, in case of its being wanted, I charge 2*d*. per cwt. for it, where it is deposited. As I design at some future time to make some alteration in the passage done with the stucco in April 1806, I had four pieces taken off, which I tied up separately, each in a piece of

of brown paper, and had them packed in a box, with a layer of sand between each piece, and at the bottom and top of the box, and directed it for you, and sent it with some goods I shipped on Saturday last to my friend Netlam Giles, Esq. No. 2, New Inn, St. Clement's. I have requested of him that he will have the goodness on its arrival to forward it to you. The vessel it goes by is the sloop Mary Anne, John Anning, master, bound to Dounes Wharf, Hermitage, Wapping. It is possible that the pieces of stucco sent may imbibe some of the saline particles from the sand it was packed in, but this did not occur to me at the time, or they should have been packed in saw-dust, as they were perfectly dry when packed, so much so as, when struck upon with the knuckle, to give a sound similar to what an earthen vessel would do if dry and not cracked. Should there be any further information requisite, on your letting me know, it shall immediately be sent you. It had almost escaped me to say, that the small quantity of six yards, done last October with stone lime for trial, was done from your intimating to me, when I had the pleasure of seeing you in Dorsetshire, that stone lime was likely to answer; but it would I think look better if white-washed; the difference in point of expense is materially in favour of the stone lime. The cost of my waggon-load of it at the kiln, about a mile from hence, would be only 10*s.*, whereas about the same quantity of chalk-lime at the kiln, full eight miles from hence, would cost 1*l.* 4*s.*, and I cannot get any chalk-lime nearer. I have only now to add that I am, very respectfully,

Sir,

Your obedient humble servant,

Bridport Harbour, April 22, 1811. H. B. WAY.

To C. Taylor, M.D. Sec.

Certificate.

I hereby certify, that Mr. H. B. Way; merchant, of Bridport Harbour, in the county of Dorset, in the month of March 1805, gave me the necessary directions for making a strong cheap stucco or plaster, which was composed of one part chalk-lime, and three equal parts of fine sand, collected on the sea shore, near Bridport Harbour, the whole of which was mixed up to a proper consistence with a strong lime water, and I have since that time done the annexed work with the said composition.

Date.

Date.	For Mr. H. B. Way, at Bridport Harbour.	Yards.	Yards Flat Measure.
1805. March.	On the outside of a warehouse wall, part rough stone and part brick - - -	25	
1806. April.	On the inside walls of a passage in his dwelling-house, on rough stone - -	10	
October and November.	On the inside rough stone walls of two cellars - - - - - - - -	224	
	One coat on the ceilings of the said cellars. N. B. The first coat on the ceilings was common hair mortar.	228	
1807. April and May.	The whole of the outside of his dwelling-house, rough stone walls - - -	335	
August.	On one side wall of the dining-room in brick; this stucco was rubbed down quite smooth, and has since been painted with oil colours - - - - -	13	
1810. October 10.	On a rough stone wall of a warehouse directly fronting the sea, and not two hundred yards from it, with common stone-lime, such as is used for manure in this quarter by way of trial - - - -	6	821
1811. April.	At Mr. H. B. Way's request, I have this day carefully examined the whole of the above work, and I find it sound and good, and by his directions, four pieces of the stucco were taken off from the passage wall, (which was laid on April 1806,) and packed in the same sort of sand as is used in the composition, and sent by him directed for the Secretary of the Society of Arts, Manufactures and Commerce, London.		
	For Peter Daniel, Esq. of Yeovil, Somersetshire.		
1808. May and June.	On the outside brick-walls of his dwelling-house there - - - - - -	430	
1810. May and June.	On the outside brick-walls of other dwelling-houses there, for W. Hellyer, Esq. of East Coke, near Yeovil - -	480	910
1809. June.	On the outside brick and rough stone-walls of his dwelling-house, at that place		1040
	For the Rev. Joseph Fawcett, of Yeovil.		
1810. June.	On the outside rough stone-walls of his dwelling-house there - - - -		212
	N. B. Mr. Fawcett's house being built the year before, with a view to being stuccoed, the walls were left rough.	Yards.	2983

I hereby

I hereby certify, that the whole of the foregoing two thousand nine hundred and eighty-three square yards of stucco were done with the before-mentioned composition, by me and my men under my directions, and I verily believe it is the cheapest stucco known, and that it will prove very durable, both without doors and within, and that it has given entire satisfaction to the gentlemen who have tried it; and I am now engaged, if I can the ensuing summer, to stucco the outside of one house at Bridport, and another at Yeovil, also the inside of a cottage for labourers that I have just built for Mr. H. B. Way, at Bridport Harbour.

THOMAS EVERETT,
Stone Mason, Bricklayer, and Plasterer.

Shipton George, near Bridport,
Dorset, April 22, 1811.

Witness, JAMES BUDDEN.

LXVI. *Cases of Hernia.* *By* JOHN TAUNTON, *Esq.*

To Mr. Tilloch.

SIR, THE following statement of the situation and occurrence of hernia at different periods of life, has been obtained principally from patients relieved by the City of London Truss Society*, and entirely under my own observation within the short period of four years and a half. It appeared to me to form an interesting article of reference, to

* The following are the outlines of the plan of this most excellent Institution. EDITOR.—"The objects of this Charity are to provide trusses for every kind of rupture—to furnish bandages and other necessary instruments for all cases of prolapsus—to perform every necessary operation—to administer surgical aid promptly—and to supply medicines and attendance during the cure of the patient.

"Annual subscribers of one guinea or more to this Charity shall be governors as long as they continue such subscription; and be at liberty to recommend three patients *within the year* for *single trusses*, or one patient for a *double*, and one for a *single truss*, for each guinea subscribed.

"Subscribers of ten guineas or upwards shall be governors for life, with the same privileges; besides being members of all committees. The moneys arising from all life subscriptions are regularly invested in the public funds.

"Mr. Taunton attends at the City Dispensary on Wednesdays and Saturdays, at one o'clock *precisely*, to examine the cases recommended; or the patients may apply at his house, No. 21, Greville-street, Hatton Garden, any morning *before nine o'clock*.

"Governors recommending patients who cannot come to London, on account of the distance, are required to send to the surgeon the *name, age*, and *residence* of the patient, the exact measure *round the body at the part* where the hernia *is seated*, and the particular *situation* of the hernia, and also to say if it can be returned when the patient lies down in bed.—All letters or orders for trusses must be *sent post paid*."

to the medical, philosophical, and general reader. As such, I have taken the liberty of transmiting it for publication in your valuable Journal, if it meets your approbation.

In 3,176 patients, 2,702 were males, and 474 were females. The situation of the hernia in each case will be seen in the following table:

704	Left inguinal	1,910 inguinal	2,194 Single.
1,206	Right inguinal		
154	Left femoral	284 femoral	
130	Right femoral		
728	Double inguinal	……………	792 Double.
64	Double femoral		
172	Umbilical	…………………	190
18	Ventral		
3,176			3,176

202	Patients were relieved with trusses, under 10 years of age.					
160	Ditto	between	10	and	20	ditto.
310	Ditto	……	20	and	30	ditto.
596	Ditto	……	30	and	40	ditto.
632	Ditto	……	40	and	50	ditto.
664	Ditto	……	50	and	60	ditto.
432	Ditto	……	60	and	70	ditto.
168	Ditto	……	70	and	80	ditto.
10	Ditto	……	80	and	90	ditto.
2	Ditto	……	90	and	100	ditto.
3,176						

From the most accurate estimation which I have been enabled to make, I have no doubt of this malady existing in one person in eight through the whole male population of this kingdom, and even in a much greater proportion among the labouring classes of the community, in manufacturing districts, particularly in those persons who are employed in weaving.

21, Greville Street, Hatton Garden,
June, 1812.

JOHN TAUNTON,
Surgeon to the City of London Truss Society, the City and Finsbury Dispensaries, and Lecturer on Anatomy and Surgery.

LXVII. *On*

LXVII. *On the Culture and Preparation of Hemp in Dorsetshire, and on the Growth of Sea Cale**.

Dear Sir, As you informed me when you was lately in Dorsetshire, that the Society of Arts, &c. were anxious to obtain information concerning the culture and preparation of hemp in this neighbourhood, I am induced to send you some accounts thereof.

I fear my memorandums on the subject will not be worthy the notice of the Society, and I should scarcely have ventured to have put pen to paper upon it, if I had not uniformly found, that the persons who are concerned in the growth and management of that article are shy of giving information. If what I have sent should induce persons equal to the task, to make the needful inquiries in this county, Somerset, Suffolk and Norfolk, (which I believe to be the parts of England where hemp is most cultivated,) and make the culture more generally known than it now seems to be, I shall be much gratified. I hope, if you again visit this neighbourhood, to show you a very fine crop of wheat on the field where you last year saw the persons employed in collecting the male hemp; also another large field of exceeding good wheat, that produced hemp last year, neither of which have had any fresh manure upon them since the hemp was taken from the fields. I have added some observations on the growth of Sea Cale: this useful vegetable, growing naturally on some of the Cliffs near Bridport Harbour, and being one of the most valuable esculent plants that I know, I have found the culture of it in the kitchen garden more easy to manage than has been generally supposed.

I have sent different specimens of the seed, and some of the natural soil, for inspection;

and remain, dear sir,

Your friend and obedient servant,

Bridport Harbour, March 1, 1811. H. B. Way.

To C. Taylor, M.D. Sec.

Account of the Culture and Preparation of Hemp in Dorsetshire.

Hemp is usually sown about the 15th of May, on the best arable land, on which about twenty cart loads of good rotten

* From *Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce*, for 1811.——The thanks of the Society were voted to Mr. Way for this communication.

rotten dung has been spread, say about a ton to the load; this is well ploughed in, and the ground well ploughed two or three times, and well dragged and harrowed, to get the soil as fine as possible, and about two or two and a half bushels of seed sown to the acre; what produces no seed, called by some male or summer hemp, and by others cinner hemp, is drawn about five or six weeks after the plant comes up, it is at that time in blossom; when drawn, it is tied up in bundles, and carried to some meadow land, and there spread to ripen: when ripe and dry, it is bundled and stacked. What stands for seed has no flower that can be discovered; it is the female hemp, and is generally ripe early in September, when it is drawn, bundled up, and stowed up in the field for the seed to dry and harden, when it is thrashed out in the fields. Most commonly in Dorset the seed is sold on the spot, at from 2*s.* 6*d.* to 7*s.* per bushel; an acre of hemp produces eighteen or twenty bushels. In Somerset they have sometimes thirty bushels of seed to the acre. In the sowing season I have known 21*s.* per bushel paid for seed; when thrashed the hemp is carried to the meadows, and spread to ripen as the other, and stacked in the same way, to prepare it for sale; it is sent to the houses of the poor in the parishes round which it is raised, to be what is called scaled, that is, each separate stalk of hemp is broken in the hand, and the hemp, which is the outside rind or bark, is stripped off, in which state it is sent to market. The scaling is the employment of old men, women and children, and of the whole of the labouring family in the evening, as in winter they make but poor wages of it, and one principal inducement for them to do it is, that the woody parts of the hemp make them a fire, but it soon burns out. Complaints are made of a great deal of the hemp being often wasted from improper management, and want of care in the scaling of it; at the Comptons and Bradford, a good deal more hemp would be raised if they could get it scaled, which they find much difficulty in doing; and if it were possible to construct a mill that would swingle it at a moderate expense, on some such plan as the flax swingling mills, and to afford some encouragement to the erecting them, as well as flax swingling mills, it would encourage the growth of both articles materially; an acre of hemp in a good season will produce 14, 16 or 18 weights, of 32lbs. to the weight in Dorsetshire; in Somersetshire they reckon their weight two pounds less, and they sometimes get as much as 35 weights to the acre; the price of the

the weight of hemp is from 16*s*. to 20*s*. per weight. The rotation of crops as follow:

On ground well manured ..... Hemp.
Wheat.
Barley or Oats.
Clover with the above.
Wheat.
Barley or Oats.
Ground well manured .... Hemp.

But sometimes they dress the ground well for hemp every third year. The quantity of hemp sown in Dorset is very trifling in comparison to what is sown in Somerset. In the former it is chiefly confined to eight or nine parishes; whereas very large quantities are raised in Somerset, in the parishes of Misterton, Crewkerne, Hinton, St. George, Lopen, Seavingtons, Ilminster, Stocklinch, Donyatt, Kingstone, Shipton, Beauchamp, Barington, South Petherton, Martlock, Norton, Chiselborough, Stoke-under-ham, Mont-a-cute, Odcombe, the Chinniocks, the Cokers, the Comptons, Bradford, and a great many other parishes. Mr. Emanuel Pester, of Preston, near Yeovil, is in the middle of the hemp and flax county, and he can doubtless obtain and give every information that may be wished on the subject, being so extensively engaged in agricultural pursuits himself, and so competent to give that sort of information wanted; a bounty of 3*d*. per stone on hemp, and 4*d*. per stone on flax, was for many years given by Government, but is now discontinued; it was paid by the Clerk of the Peace for the counties; and as the late Mr. Wallace managed that for the county of Dorset uncommonly well, it is most probable that a very correct return for the county of Dorset could be obtained from the office of the Clerk of the Peace for this county, of the quantity raised each year of both articles, during the continuance of the bounty; also from Devon and Somerset similar returns could be got. There are large quantities of hemp raised in Suffolk, the writer thinks, near St. Edmunds Bury and Stow market, in that county. He has been told they make linen so fine of hemp, as to be worth 5*s*. and 6*s*. per yard, and used for shirts in preference to Irish, being considered much more durable and better, so much so, as to induce the Irish to imitate the fabric, and stamp the cloth, Suffolk Hemp. It is also raised in Norfolk, in the neighbourhood of Lynn and Wisbeach, but it must be watered and prepared in some other way; indeed he is convinced that all the hemp imported from the Baltic is prepared differently from the mode used in Dorset and Somerset,

Somerset, and must have been swingled before it was sent to the different ports it was shipped at for this country. The giving the former bounty on the growth, and increasing it on hemp and flax, would encourage the growth; but if given on the number of acres sown, the grower, as his ground would be in high order for a crop of turnips and wheat after, might be careless about his crop of hemp, as the bounty, to be worth notice, must be worth more than the value of the seed in common years and the labour of sowing.

Hemp in this county and the next is never sown in new ground fresh broke up, but flax always by choice, when fresh ground can be got. Mr. John Pitfield is going to break up great part of the West Clift at Bridport Harbour, and sow it with flax this season. The writer, while on the subject of hemp, is led to mention, that when travelling in the year 1792, in the province of Massachusets near Boston, in North America, was assured that considerable quantities of hemp were raised in the township of Sunberry, about ten miles from Boston, and that it was always raised on the same ground every year, no other crop being sown in their hemp lands, and that it was manured every year, at the rate of about ten tons of manure to the acre of hemp. Respecting seed, he cannot learn that there is any for sale at Bridport, with the buyers who purchase it up for the growers at the hemp harvest, and he expects that very little can be got from the growers round here. Somersetshire is a more likely place to get it, as he has known some of the hemp farmers to have upwards of an hundred acres of hemp in one season; round this they generally are only in a small way. A change of hemp seed is much wanted in Somerset and Dorset. Trials have been made two or three times to get it from Russia; but it is not possible to get new seed from the interior early enough in the fall at the shipping ports, and some old seed which has been shipped has not answered the purpose; if new could have been got, it would as generally have been used for a change, as the new Riga barrel flax seed is by the flax-growers. As the seed sown in Russia was considered a good sample, and its appearance much liked, possibly it might, at a future period, be obtained in the fall from Odesea, or some other port on the Black Sea, as it is understood that a good deal of hemp shipped at Riga and St. Petersburgh grows much nearer to the Black Sea than the Baltic; or possibly the seed of the Italian hemp raised in the neighbourhood of Bologna, or that of America, might be obtained in time to answer.

Perhaps

Perhaps tares, called by some vetches, might be cleared from the ground early enough for manuring and sowing the ensuing crop of hemp, and vetches might make it worth the farmer's attention: to this an objection was stated, which I do not just now remember. On talking with the gentleman before mentioned, and stating the American practice, with what had passed on it with my neighbours, he said, he had long been persuaded that it was a good practice, and that he had the last season a very good crop of hemp on a piece of ground that had hemp the year before, and that he did not let the hemp stand for seed, but had it all down at the usual time for drawing the summer or male hemp, and the ground immediately sown with turnips, which were fed-off with sheep, and the ground then slightly manured, and hemp sown again at the proper season; and that he had then, October 27, 1808, a piece of turnips after his hemp, which were worth 6*l.* per acre. It is to be observed, that the acre here meant is the British acre of one hundred square poles, three hundred and four square yards each. The manure mostly used for hemp is good rotten stable dung, which is much preferred to any other, though lime is frequently used; but manufacturers pretend to assert, (with what foundation I cannot say,) that they can distinguish a material difference in the quality of the hemp, where lime has been used instead of dung, as from lime they say hemp is more harsh and brittle, and not of such a soft silky quality as where dung has been used. The writer has endeavoured to throw together every thing that occurs to him on the subject of the culture of hemp, which, from being born and residing great part of his life in a part of the county where it has been extensively cultivated for ages, he has been able to collect; but where it is not very easy to obtain direct information, as both the growers and manufacturers are very shy of giving any, under an idea that it might injure their own interest by assisting to extend the culture to other countries. He believes that his statement may be depended upon; but he is no farmer, and therefore the loose hints thrown together here on the subject may not be so clearly and satisfactorily explained as he could wish; but if they in the smallest degree assist in encouraging the growth of an article so essential to the welware and prosperity of the kingdom, it will afford him the most heartfelt pleasure.

H. B. Way.

Account of the Culture of Sea-Cale, or Sea-Kale.

The mode which I consider the best for the culture of sea-cale, is to draw lines in a very dry soil and dry situation, on ground with a southern aspect, about two feet one way by about eighteen inches the other, and where the lines cross to put in three or four good perfect seeds in a square or triangle, about three inches apart; this may be done any time in November or December in open weather, and it will require no other care afterwards but keeping the ground clear from weeds till the autumn of the following year, when all the plants but one of the finest in each square may be taken up, which if wanted will serve to form other beds set the same distance apart. The ground in the intervals of the plants should be dug in the spring and fall of the year, taking care not to injure the plants. The leaves should be left on the plants till they fall off naturally, which will not in general be sooner than the latter end of November. In the autumn of the second year the same attention should be paid to the plants, and to remove the dead leaves.

In the third year, about the middle or latter end of November, when the leaves have been cleared away, and the ground dug, each plant should be covered over close with a tub, pan, a heap of small stones, coarse cinders, or coarse bark, raised about ten or twelve inches over the crown of each plant, and from about the latter end of February to the latter end of March the plants will be very fine and fit for use. I prefer that which has been bleached with our round sea-gravel, about the size of large peas or beans, to any other mode whatever. The plants should be cut but once in a year, as cutting it oftener weakens and lessens the size of the plants. If it is not desired to have the plants large, they may be bleached and cut a year sooner.

I have sent a specimen of the sandy soil in which it grows naturally here, as I think the generality of gardeners are too careful, and manure the ground too highly for it. In the month of April last, after cutting my plants, I covered the ground all over, at least six inches above the crown of the plants, with this earth: they soon shot up through it, and never looked finer or produced a larger quantity of good seed than that year.

I am thus particular in order to show that this vegetable will succeed as well, if not better in poor ground than in rich, provided the soil be dry, and care taken in the management; I speak from long experience, having been well acquainted with the management of this valuable plant from my

my youth. When I cut the sea-cale for use, I immediately draw up the earth with a trowel, so as completely to cover the whole of the plant; this I fancy makes them grow more luxuriantly. This plant, if properly managed, is superior to asparagus, and if more is cut than wanted for immediate use, it will keep for some days in a pan of cold water, but of course it cannot be better than when recently cut. It precedes the use of asparagus, being ready for the table in February and March.

H. B. WAY.

LXVIII. *On a gaseous Compound of carbonic Oxide and Chlorine.* By JOHN DAVY, *Esq.* *Communicated by Sir* HUMPHRY DAVY, *Knt. LL.D. Sec. R.S.**

SINCE the influence of electricity and solar light, as chemical agents, are analogous in many respects, and as the former produces no change in a mixture of carbonic oxide and chlorine, it was natural to infer the same respecting the latter. MM. Gay Lussac and Thenard assert that this is the case; they say that they have exposed a mixture of carbonic oxide and chlorine, under all circumstances, to light, without observing any alteration to take place †. Mr. Murray has made a similar statement ‡.

Having been led to repeat this experiment, from some objections made by the last-mentioned gentleman to the theory of my brother, Sir Humphry Davy, concerning chlorine, I was surprised at witnessing a different result.

The mixture exposed, consisted of about equal volumes of chlorine and carbonic oxide; the gasses had been previously dried over mercury by the action of fused muriate of lime, and the exhausted glass globe into which they were introduced from a receiver with suitable stopcocks, was carefully dried. After exposure for about a quarter of an hour to bright sunshine, the colour of the chlorine had entirely disappeared; the stopcock belonging to the globe being turned in mercury recently boiled, a considerable absorption took place, just equal to one half the volume of the mixture, and the residual gas possessed properties perfectly distinct from those belonging either to carbonic oxide or chlorine.

Thrown into the atmosphere, it did not fume. Its odour

* From the Philosophical Transactions for 1812, part i.

† Recherches Physico-Chimiques, tom. ii. p. 150.

‡ Nicholson's Journal, vol. xxx. p. 227.

was

was different from that of chlorine, something like that which one might imagine would result from the smell of chlorine combined with that of ammonia, yet more intolerable and suffocating than chlorine itself, and affecting the eyes in a peculiar manner, producing a rapid flow of tears and occasioning painful sensations.

Its chemical properties were not less decidedly marked than its physical ones.

Thrown into a tube full of mercury containing a slip of dry litmus paper, it immediately rendered the paper red.

Mixed with ammoniacal gas, a rapid condensation took place, a white salt was formed, and much heat was produced.

The compound of this gas and ammonia was a perfect neutral salt, neither changing the colour of turmeric or litmus; it had no perceptible odour, but a pungent saline taste; it was deliquescent, and of course very soluble in water; it was decomposed by the sulphuric, nitric, and phosphoric acids, and also by liquid muriatic acid; but it sublimed unaltered in the muriatic, carbonic, and sulphureous acid gasses, and dissolved without effervescing in acetic acid. The products of its decomposition collected over mercury were found to be the carbonic and muriatic acid gasses; and in the experiment with concentrated sulphuric acid when accurate results could be obtained, these two gasses were in such proportions, that the volume of the latter was double that of the former.

I have ascertained by repeated trials, both synthetical and analytical, that the gas condenses four times its volume of the volatile alkali, and I have not been able to combine it with a smaller proportion.

Tin fused in the gas in a bent glass tube over mercury, by means of a spirit lamp, rapidly decomposed it; the liquor of Libavius was formed; and when the vessel had cooled, there was not the least change of the volume of the gas perceptible; but the gas had entirely lost its offensive odour, and was merely carbonic oxide; for like carbonic oxide it burnt with a blue flame, afforded carbonic acid by its combustion, and was not absorbable by water.

The effects of zinc, antimony, and arsenic heated in the gas, were similar to those of tin; compounds of these metals and chlorine were formed, and carbonic oxide in each experiment was liberated equal in volume to the gas decomposed. In each instance the action of the metal was quick; the decomposition being completed in less than ten minutes; but though the action was rapid, it was likewise tranquil,

tranquil, no explosion ever took place, and none of the metals became ignited or inflamed.

The action even of potassium heated in the gas was not violent But from the great absorption of gas, and from the precipitation of carbon indicated by the blackness produced, not only the new gas, but likewise the carbonic oxide, appeared to be decomposed.

The white oxide of zinc heated in the gas quickly decomposed it, just as readily indeed as the metal itself; there was the same formation of the butter of zinc; but instead of carbonic oxide being produced, carbonic acid was formed; and, as usual, there was no change of volume.

The protoxide of antimony fused in the gas rapidly decomposed it; the butter of antimony and the infusible peroxide were formed; there was no change of the volume of the gas, and the residual gas was carbonic oxide.

Sulphur and phosphorus sublimed in the gas, produced no apparent change; the volume of the gas was unaltered, and its characteristic smell was undiminished.

Mixed with hydrogen or oxygen singly, the gas was not inflamed by the electric spark, but mixed with both, in proper proportions, viz. two parts in volume of the former and one of the latter to two parts of the gas, a violent explosion was produced, and the muriatic and carbonic acid gasses were formed.

The gas transferred to water was quickly decomposed, the carbonic and muriatic acids were formed, as in the last experiment, and the effect was the same even when light was excluded.

From the mode of the formation of the gas and the condensation that takes place at the time, from the results of the decomposition of its ammoniacal salt, and from the analysis of the gas by metals and metallic oxides, it appears to be a compound of carbonic oxide and chlorine condensed into half the space which they occupied separately.

And from its combining with ammonia, and forming with this alkali a neutral salt, and from its reddening litmus, it seems to be an acid It is similar to acids in other respects; in decomposing the dry sub-carbonate of ammonia, one part in volume of it expelling two parts of carbonic acid gas; and in being itself not expelled from ammonia by any of the acid gasses, or by acetic acid. Independent of these circumstances, were power of saturation to be taken as the measure of affinity, the attraction of this gas for ammonia must be allowed to be greater than that of any other substance, for its saturating power is greater; no

 acid

acid condenses so large a proportion of ammonia; carbonic acid only condenses half as much, and yet does not form a neutral salt. The great saturating and neutralizing powers of this gas are singular circumstances, and particularly singular when compared with those of muriatic acid gas.

In consequence of its being decomposed by water, I have not been able to ascertain whether it is capable of combining with the fixed alkalies. Added to solutions of these substances it was absorbed, and carbonic acid gas was disengaged by an acid.

I have made the experiment on the native carbonates of lime and barytes, but the gas did not decompose these bodies. This indeed might be expected, since quick-lime, I find, does not absorb the gas: a cubic inch of it, exposed to the action of lime in a tube over mercury, was only diminished in two days to nine-tenths of a cubic inch, and no further absorption was afterwards observed to take place. But even this circumstance does not demonstrate that the gas has no affinity for lime, and is not capable of combining with it; for on making a similar experiment with carbonic acid, substituting this gas for the new compound, the result was the same; in two days only about one-tenth of a cubic inch was absorbed.

Though the gas is decomposed by water, yet it appears to be absorbed unaltered by common spirits of wine, which contains so considerable a quantity of water; it imparted its peculiar odour to the spirit, and its property of affecting the eyes; five measures of the spirit condensed sixty measures of the gas.

It is also absorbed by the fuming liquor of arsenic, and by the oxymuriate of sulphur.

The former appeared to require for saturation ten times its own volume; six measures of the liquor condensed about sixty of the gas. The liquor thus impregnated was thrown into water, and a pretty appearance was produced by the sudden escape of bubbles of the gas: had not its intolerable smell convinced me that the gas was unaltered, I should not have conceived that it could pass through water undecomposed.

I cannot account for the assertion of MM. Gay Lussac and Thenard and of Mr. Murray, that oxymuriatic gas does not, when under the influence of light, exert any action on carbonic oxide: I was inclined at first to suppose that the difference between their results and mine, might be owing to their not having exposed the gasses together to bright sunshine; but I have been obliged to relinquish this idea,

idea, since I have found that bright sunshine is not essential, and that the combination is produced in less than twelve hours by the indirect solar rays, light alone being necessary.

The formation of the new gas may be very readily witnessed, by making a mixture of dry carbonic oxide and chlorine in a glass tube over mercury: if light be excluded, the chlorine will be absorbed by the mercury, the carbonic oxide alone remaining; but if bright sunshine be immediately admitted when the mixture first is made, a rapid ascension of the mercury will take place, and in less than a minute the colour of the chlorine will be destroyed, and in about ten minutes the condensation will have ceased, and the combination of the two gasses will be complete.

It is requisite that the gasses should be dried for forming this compound; if this precaution is neglected, the new gas will be far from pure; it will contain a considerable admixture of the carbonic and muriatic acid gasses, which are produced in consequence of the decomposition of hygrometrical water. Indeed there is considerable difficulty in procuring the new gas tolerably pure; a good air pump is required, and perfectly tight stopcocks, and dry gasses, and dry vessels.

I have endeavoured to procure the gas, by passing a mixture of carbonic oxide and chlorine through an earthenware tube heated to redness; but without success.

The specific gravity of the gas may be inferred from the specific gravities of its constituent parts jointly with the condensation that takes place at their union. According to Cruickshank, 100 cubic inches of carbonic oxide weigh 29·6 grains, and according to Sir Humphry Davy, 100 of chlorine are equal to 76·37 grains: hence, as equal volumes of these gasses combine, and become so condensed as to occupy only half the space they before filled, it follows that 100 cubic inches of the new compound gas are equal to 105·97 grains. Thus this gas exceeds most others as much in its density as it does in its saturating power.

To ascertain whether chlorine has a stronger affinity for hydrogen than for carbonic oxide, I exposed a mixture of the three gasses in equal volumes to light. Both the new compound and muriatic acid gas were formed, and the affinities were so nicely balanced, that the chlorine was nearly equally divided between them. And that the attraction of chlorine for both these gasses is nearly the same, appears to be confirmed by muriatic acid not being decomposed by carbonic oxide, or the new gas by hydrogen.

 The

The chlorine and carbonic oxide are, it is evident from these last facts, united by strong attractions; and as the properties of the substance as a peculiar compound are well characterized, it will be necessary to designate it by some simple name. I venture to propose that of phosgene, or phosgene gas; from *φως*, light, and *γινομαι*, to produce, which signifies formed by light; and as yet no other mode of producing it has been discovered.

I have exposed mixtures consisting of different proportions of chlorine and carbonic acid to light; but have obtained no new compound.

The proportions in which bodies combine appear to be determined by fixed laws, which are exemplified in a variety of instances, and particularly in the present compound. Oxygen combines with twice its volume of hydrogen and twice its volume of carbonic oxide to form water and carbonic acid, and with half its volume of chlorine to form euchlorine; and chlorine reciprocally requires its own volume of hydrogen and its own volume of carbonic oxide to form muriatic acid and the new gas.

This relation of proportions is one of the most beautiful parts of chemical philosophy, and that which promises fairest, when prosecuted, to raise chemistry to the state and certainty of a mathematical science.

LXIX. *New Tables for finding the Deviation of a Star in North Polar Distance and Right Ascension. By Mr.* T. Firminger, *late Assistant Astronomer at the Royal Observatory, Greenwich* *.

In the present improved state of astronomy, every means which tends to simplify calculation is readily embraced by the practical astronomer. With this view a variety of tables at different times have been published, and some of them so concise and simple that they seem to afford but little if any room for further improvement; whilst others, however, have not yet been so far improved, but that they still admit of a considerable degree of simplification; and of these the means of determining the nutation of a star in north polar distance from tables as heitherto published, is an instance.

Finding a considerable inconvenience in the computation of this equation of constant use in the reduction of meridional zenith distances from Dr. Maskelyne's Tables, published

* Master of an Academy for the Instruction of a limited Number of Young Gentlemen in the Theory and Practice of the Mathematics and Mathematical Sciences.

published at the end of the Greeenwich Observations of the year 1798, wherein the argument is applied to take out the equation by double entry, induced me to compute new tables for more readily finding it. The formula which I deduced for this purpose, is expressed by $-1'',22 \times s,$ $(\ast Æ + \text{Long. } ☽^s ☊) + 8'',33^s (\ast Æ - \text{Long. } ☽^s ☊)$ taking the semi-axis major and minor at $9'',55$ and $7'',11$ respectively. The table will therefore be easily computed at any subsequent period, should the major and minor axis of the ellipse of nutation be hereafter determined of different values from that which has been used in the above formulæ.

In taking out the equation of nutation, the algebraic sum of the two parts of the table, give the whole equation, entering the first part of the table with sum of the star's right ascension, and longitude of the moon's ascending node; and the second part of the table with the right ascension of the star minus the longitude of the moon's ascending node.

Examples.

Example 1. To find the nutation in north polar distance for Arcturus, on July 1, 1812.

Right ascension Arcturus	7^s	$1°$	$47'$	$39''$		
Longitude ☽^{s} ☊	5	1	31	00		
✱^{s} Æ + Long. ☽^{s} ☊ .	0	3	18	39	Part I	$-0'',06$
✱^{s} Æ − Long. ☽^{s} ☊ .	2	0	16	39	Part II	$-7'',22$
					Nutation required ...	$-7'',28$

To find the deviation of Sirius in north polar distance on July 1, 1812.

Right ascension Sirius ..	3^s	$9°$	$13'$	$28''$	
Long. ☽^{s} ☊	5	1	31	00	
✱^{s} Æ + Long. ☽^{s} ☊ ..	8	10	44	28	$+1'',13$
✱^{s} Æ − Long. ☽^{s} ☊ .	10	7	42	28	$+6'',60$
				Deviation required ...	$+7'',73$

When the longitude of the moon's ascending node exceeds the star's right ascension, as in the last example; twelve signs must be added to the star's right ascension before the subtraction can be made.

These tables may be also applied to finding the deviation of a star in right ascension, but in this they require a little more

more labour than in the above application. The method is by adding three signs to the star's right ascension, if its declination is north; and on the contrary, subtract three signs if the declination be south: then proceed as directed above, and multiply the equation so found by the natural tangent of the star's declination, and the product converted into time will give the deviation required.

	✱ˢ A.R. + Long. ☽ˢ ☊			
S. S.	0 — VI +	I — VII +	II — VIII +	
	″	″	″	°
0	0,00	0,60	1,04	30
1	0,02	0,62	1,05	29
2	0,04	0,64	1,06	28
3	0,06	0,65	1,07	27
4	0,08	0,67	1,08	26
5	0,10	0,69	1,09	25
6	0,13	0,71	1,10	24
7	0,15	0,72	1,10	23
8	0,17	0,74	1,11	22
9	0,19	0,76	1,12	21
10	0,21	0,77	1,13	20
11	0,23	0,79	1,13	19
12	0,25	0,80	1,14	18
13	0,27	0,82	1,15	17
14	0,29	0,83	1,15	16
15	0,31	0,85	1,16	15
16	0,33	0,86	1,16	14
17	0,35	0,88	1,17	13
18	0,37	0,89	1,17	12
19	0,39	0,91	1,18	11
20	0,41	0,92	1,18	10
21	0,43	0,93	1,19	9
22	0,45	0,95	1,19	8
23	0,47	0,96	1,19	7
24	0,49	0,97	1,19	6
25	0,51	0,98	1,20	5
26	0,53	0,99	1,20	4
27	0,54	1,01	1,20	3
28	0,56	1,02	1,20	2
29	0,58	1,03	1,21	1
30	0,60	1,04	1,21	0
	XI + V —	X + IV —	IX + III —	

	✱ A.R. — Long. ☽ˢ ☊			
S. S.	0 — VI +	I — VII +	II — VIII +	
	″	″	″	°
0	0,00	4,17	7,22	30
1	0,15	4,30	7,29	29
2	0,29	4,42	7,36	28
3	0,43	4,54	7,43	27
4	0,58	4,66	7,50	26
5	0,73	4,78	7.56	25
6	0,87	4,90	7,62	24
7	1,02	5,02	7,68	23
8	1,16	5,14	7,73	22
9	1,30	5,25	7,79	21
10	1,45	5.36	7,84	20
11	1,59	5,47	7,89	19
12	1,73	5,58	7.93	18
13	1,88	5,69	7,98	17
14	2,02	5,79	8,02	16
15	2,16	5,89	8,06	15
16	2,29	6,00	8,09	14
17	2,44	6,10	8,13	13
18	2,58	6,20	8,16	12
19	2,72	6,29	8,19	11
20	2,86	6,40	8,21	10
21	2,99	6,48	8,24	9
22	3.12	6.57	8,26	8
23	3,26	6,66	8,28	7
24	3,39	6,75	8,29	6
25	3,53	6,82	8,31	5
26	3,66	6,91	8,32	4
27	3,79	6,99	8,33	3
28	3,92	7,07	8,34	2
29	4,04	7,15	8,34	1
30	4,17	7,22	8,34	0
	XI + V —	X + IV —	IX + III —	

LXX. *A Nar-*

LXX. *A Narrative of the Eruption of a Volcano in the Sea off the Island of St. Michael. By* S. TILLARD, *Esq. Captain in the Royal Navy. Communicated by the Right Hon. Sir* JOSEPH BANKS, *Bart. K.B.P.R.S.**

APPROACHING the island of St. Michael's, on Sunday the 12th of June 1811, in His Majesty's sloop Sabrina under my command, we occasionally observed, rising in the horizon, two or three columns of smoke, such as would have been occasioned by an action between two ships, to which cause we universally attributed its origin. This opinion was, however, in a very short time changed, from the smoke increasing and ascending in much larger bodies than could possibly have been produced by such an event; and having heard an account, prior to our sailing from Lisbon, that in the preceding January or February a volcano had burst out within the sea near St. Michael's, we immediately concluded that the smoke we saw proceeded from that cause, and on our anchoring the next morning in the road of Ponta del Gada, we found this conjecture correct as to the cause, but not to the time; the eruption of January having totally subsided, and the present one having only burst forth two days prior to our approach, and about three miles distant from the one before alluded to.

Desirous of examining as minutely as possible a contention so extraordinary between two such powerful elements, I set off from the city of Ponta del Gada on the morning of the 14th, in company with Mr. Read, the Consul General of the Azores, and two other gentlemen. After riding about twenty miles across the NW. end of the island of St. Michael's, we came to the edge of a cliff from whence the volcano burst suddenly upon our view in the most terrific and awful grandeur. It was only a short mile from the base of the cliff, which was nearly perpendicular, and formed the margin of the sea; this cliff being as nearly as I could judge from three to four hundred feet high. To give you an adequate idea of the scene by description is far beyond my powers; but for your satisfaction I shall attempt it.

Imagine an immense body of smoke rising from the sea, the surface which was marked by the silvery ripling of the waves, occasioned by the light and steady breezes incidental to those climates in summer. In a quiescent state, it had the appearance of a circular cloud revolving on the water like

* From the Philosophical Transactions for 1812, part i.

like an horizontal wheel, in various and irregular involutions, expanding itself gradually on the lee side, when suddenly a column of the blackest cinders, ashes, and stones would shoot up in form of a spire at an angle of from ten to twenty degrees from a perpendicular line, the angle of inclination being universally to windward: this was rapidly succeeded by a second, third, and fourth, each acquiring greater velocity, and overtopping the other till they had attained an altitude as much above the level of our eye, as the sea was below it.

As the impetus with which the columns were severally propelled diminished, and their ascending motion had nearly ceased, they broke into various branches resembling a groupe of pines, these again forming themselves into festoons of white feathery smoke in the most fanciful manner imaginable, intermixed with the finest particles of falling ashes, which at one time assumed the appearance of innumerable plumes of black and white ostrich feathers surmounting each other; at another, that of the light wavy branches of a weeping willow.

During these bursts, the most vivid flashes of lightning continually issued from the densest part of the volcano; and the cloud of smoke now ascending to an altitude much above the highest point to which the ashes were projected, rolled off in large masses of fleecy clouds, gradually expanding themselves before the wind in a direction nearly horizontal, and drawing up to them a quantity of water spouts, which formed a most beautiful and striking addition to the general appearance of the scene.

That part of the sea where the volcano was situated, was upwards of thirty fathoms deep, and at the time of our viewing it the volcano was only four days old. Soon after our arrival on the cliff, a peasant observed he could discern a peak above the water: we looked, but could not see it: however, in less than half an hour it was plainly visible, and before we quitted the place, which was about three hours from the time of our arrival, a complete crater was formed above the water, not less than twenty feet high on the side where the greatest quantity of ashes fell; the diameter of the crater being apparently about four or five hundred feet.

The great eruptions were generally attended with a noise like the continued firing of cannon and musquetry intermixed, as also with slight shocks of earthquakes, several of which having been felt by my companions, but none by myself, I had become half sceptical, and thought their opinion

opinion arose merely from the force of imagination: but while we were sitting within five or six yards of the edge of the cliff, partaking of a slight repast which had been brought with us, and were all busily engaged, one of the most magnificent bursts took place which we had yet witnessed, accompanied by a very severe shock of an earthquake. The instantaneous and involuntary movement of each was to spring upon his feet, and I said "This admits of no doubt." The words had scarce passed my lips, before we observed a large portion of the face of the cliff, about fifty yards on our left, falling, which it did with a violent crash. So soon as our first consternation had a little subsided, we removed about ten or a dozen yards further from the edge of the cliff, and finished our dinner.

On the succeeding day, June 15th, having the Consul and some other friends on board, I weighed, and proceeded with the ship towards the volcano, with the intention of witnessing a night view; but in this expectation we were greatly disappointed, from the wind freshening and the weather becoming thick and hazy, and also from the volcano itself being clearly more quiescent than it was the preceding day. It seldom emitted any lightning, but occasionally as much flame as may be seen to issue from the top of a glass-house or foundery chimney.

On passing directly under the great cloud of smoke, about three or four miles distant from the volcano, the decks of the ship were covered with fine black ashes, which fell intermixt with small rain. We returned the next morning, and late on the evening of the same day I took my leave of St. Michael's to complete my cruize.

On opening the volcano clear of the NW. part of the island, after dark on the 16th, we witnessed one or two eruptions that, had the ship been near enough, would have been awfully grand. It appeared one continued blaze of lightning; but the distance which it was at from the ship, upwards of twenty miles, prevented our seeing it with effect.

Returning again towards St. Michael's on the 4th of July, I was obliged, by the state of the wind, to pass with the ship very close to the island, which was now completely formed by the volcano, being nearly the height of Matlock High Tor, about eighty yards above the sea. At this time it was perfectly tranquil; which circumstance determined me to land, and explore it more narrowly.

I left the ship in one of the boats, accompanied by some of the officers. As we approached, we perceived that it was

was still smoking in many parts, and upon our reaching the island found the surf on the beach very high. Rowing round to the lee side, with some little difficulty, by the aid of an oar, as a pole, I jumped on shore, and was followed by the other officers. We found a narrow beach of black ashes, from which the side of the island rose in general too steep to admit of our ascending; and where we could have clambered up, the mass of matter was much too hot to allow our proceeding more than a few yards in the ascent.

The declivity below the surface of the sea was equally steep, having seven fathoms water scarce the boat's length from the shore, and at the distance of twenty or thirty yards we sounded twenty-five fathoms.

From walking round it in about twelve minutes, I should judge that it was something less than a mile in circumference; but the most extraordinary part was the crater, the mouth of which, on the side facing St. Michael's, was nearly level with the sea. It was filled with water, at that time boiling, and was emptying itself into the sea by a small stream about six yards over, and by which I should suppose it was continually filled again at high water. This stream, close to the edge of the sea, was so hot, as only to admit the finger to be dipped suddenly in, and taken out again immediately.

It appeared evident, by the formation of this part of the island, that the sea had, during the eruptions, broke into the crater in two places, as the east side of the small stream was bounded by a precipice, a cliff between twenty and thirty feet high forming a peninsula of about the same dimensions in width, and from fifty to sixty feet long, connected with the other part of the island by a narrow ridge of cinders and lava, as an isthmus of from forty to fifty feet in length, from which the crater rose in the form of an amphitheatre.

This cliff, at two or three miles distance from the island, had the appearance of a work of art resembling a small fort or block house. The top of this we were determined, if possible, to attain; but the difficulty we had to encounter in doing so was considerable; the only way to attempt it was up the side of the isthmus, which was so steep, that the only mode by which we could effect it, was by fixing the end of an oar at the base, with the assistance of which we forced ourselves up in nearly a backward direction.

Having reached the summit of the isthmus, we found another difficulty, for it was impossible to walk upon it, as the

the descent on the other side was immediate, and as steep as the one we had ascended; but by throwing our legs across it, as would be done on the ridge of a house, and moving ourselves forward by our hands, we at length reached that part of it where it gradually widened itself and formed the summit of the cliff, which we found to have a perfectly flat surface, of the dimensions before stated.

Judging this to be the most conspicuous situation, we here planted the Union, and left a bottle sealed up containing a small account of the origin of the island, and of our having landed upon it, and naming it Sabrina Island.

Within the crater I found the complete skeleton of a guard-fish, the bones of which being perfectly burnt, fell to pieces upon attempting to take them up; and by the account of the inhabitants on the coast of St. Michael's, great numbers of fish had been destroyed during the early part of the eruption, as large quantities, probably suffocated or poisoned, were occasionally found drifted into the small inlets or bays.

The island, like other volcanic productions, is composed principally of porous substances, and generally burnt to complete cinders, with occasional masses of a stone, which I should suppose to be a mixture of iron and lime-stone; but have sent you specimens to enable you to form a better judgement than you possibly can by any description of mine.

LXX. *On the primitive Crystals of Carbonate of Lime, Bitter-Spar, and Iron-Spar. By* WILLIAM HYDE WOLLASTON, *M.D. Sec. R.S.**

WHEN I formerly described to the society a goniometer † upon a new construction for measuring the angles of crystals, I expressed an expectation that we should thereby be enabled to correct former observations made by means of less accurate instruments. I took occasion to mention one instance of inaccurate measurement in the primitive angle of the common carbonate of lime; and I have had the satisfaction to find the necessity of a correction, in that instance, confirmed by Mons. Malus, and admitted by the Abbé Haüy, in a work ‡ published nearly at the same time.

* From the Philosophical Transactions for 1812, part i.

† Philosophical Transactions for 1809. See Phil. Mag. vol. xxxv. p. 94.

‡ Tableau Comparatif des Résultats de la Crystallographie et de l'Analyse Chimique.

It

It is by no means my design to detract in any degree from the merit of that justly celebrated crystallographer, to the surprising accuracy of whose measurements I could, in various instances, bear testimony. I hope, on the contrary, that in bringing forward two more observations similar to the preceding, and intimately connected with it, I shall offer what will not only appear interesting to crystallographers in general, but will be peculiarly gratifying to the Abbé Haüy.

In his Traité de Minéralogie, and again more recently in his Tableau Comparatif, the same primitive form is assigned to three substances very different in their composition, to carbonate of lime, to magnesian carbonate of lime (or bitter-spar), and to carbonate of iron.

It has been objected to Mons. Haüy, that according to his method identity of form should be accompanied by identity of composition, unless the form were one of the common regular solids. For though in that case any geometrician would readily admit it to be very probable, that many different substances might concur in assuming the same form of cube, of octohedron, or of dodecahedron, &c. there does not appear a corresponding probability that any two dissimilar substances would assume the same form of a particular rhomboid of 105° and a few minutes, to which no such geometric regularity or peculiar simplicity can be ascribed.

But though so accurate a correspondence, as has been hitherto supposed to exist in the measures of the three carbonates above mentioned, might be justly considered as highly improbable, no degree of improbability whatever attaches to the supposition, that their angles approach each other by some difference, so small as hitherto to have escaped detection. And this in fact I find to be the case.

Since the angles observable in *fractures* of crystalline substances are subject to vary a little at different surfaces, and even in different parts of the same surface (as is evident from the confused image seen by reflection from them), I shall not at present undertake to determine the angles of these bodies to less than five minutes of a degree. This, indeed, is the smallest division of the goniometer that I usually employ, as I purposely decline giving so much time to these inquiries as would be requisite for attempting to arrive at greater precision.

The most accurate determination of the angle of carbonate of lime is probably that of Mons. Malus, who measured it by means of a repeating circle, and found it to be

105° 5′,

105° 5′. And this, indeed, is the result to which I formerly came by a different method *. If it differ in any respect from this quantity, I am inclined to think that it will more likely be found to be deficient by a few minutes, than to exceed the measure here assigned; and accordingly to differ still more widely from those angles which I am about to mention.

In the magnesian carbonate of lime, or bitter-spar, the primitive form is well known to be a regular rhomboid, as well as that of carbonate of lime, and so nearly resembling it, as to have been hitherto supposed the same. I find, however, a difference of 1° 10′ in the measures of these crystals; for that of the magnesian carbonate is full 106¼°, as I have observed with uniformity in at least five different specimens of this substance obtained from situations very distant from each other.

The primitive angle of iron-spar is still more remote from that of the carbonate of lime, which it exceeds by nearly two degrees. I have examined various specimens of this substance, some pure white, others brown, some transparent, others opake. That which gives the most distinct image by reflection is of a brownish hue, with the semi-transparency of horn. It was obtained from a tin mine, called Maudlin Mine, near Lostwithiel in Cornwall. By repeated measurement of small fragments of this specimen, the angle appears to be so nearly 107°, that I cannot form any judgement whether in perfect crystals it will prove to be greater or less than that angle.

In this instance the carbonate of iron is nearly pure, and so perfectly free from carbonate of lime, as to render it highly probable that in other specimens having the same angle, but containing also carbonate of lime or other ingredients intermixed, the form is really dependent on the carbonate of iron alone.

It appears however not unlikely, that when substances which agree so nearly in their primitive angle are intermixed in certain proportions, they may each exert their power; and may occasion that confused appearance of crystallization with curved surfaces, known by the name of pearl-spar. I cannot say that I have made any accurate comparative analyses which may be adduced in support of the hypothesis, that mixtures are more subject to curvature than pure chemical compounds; but it is very evident from the numerous analyses that have been made of iron-spar by

* Phil. Trans. 1802, p. 385.

 other

other chemists, how extremely variable they are in their composition, and consequently how probable it is, that the greater part of them are to be regarded as mixtures; although it be also possible, that there may exist a triple carbonate of lime and iron as a strict chemical compound.

It seems not unlikely, that there may hereafter be found some carbonate allied to the preceding, which may owe its form to the presence of manganese: but notwithstanding the liberality which happily prevails in general among those who have it in their power to assist in such inquiries, I have not had the good fortune to meet with any such compound; and I am unwilling, merely in the hope of making such an addition, any longer to defer communicating an observation, which I hope will be of real utility in the discrimination of bodies that differ so essentially in their composition.

LXXII. *Notices respecting New Books.*

PART I. of the Philosophical Transactions of the Royal Society for 1812 has just made its appearance. The following are its contents:

1. On the Grounds of the Method which Laplace has given in the second Chapter of the third Book of his Mécanique Céleste for computing the Attractions of Spheroids of every Description. By James Ivory, A.M. Communicated by Henry Brougham, Esq., F.R.S. M.P.—2. On the Attractions of an extensive Class of Spheroids. By J. Ivory, A.M. Communicated by Henry Brougham, Esq. F.R.S. M.P.—3. An Account of some Peculiarities in the Structure of the Organ of Hearing in the Balæna Mysticetus of Linnæus. By Everard Home, Esq., F.R.S.—4. Chemical Researches on the Blood, and some other Animal Fluids. By William Thomas Brande, Esq., F.R.S. Communicated to the Society tor the Improvement of Animal Chemistry, and by them to the Royal Society.—5. Observations of a Comet, with Remarks on the Construction of its different Parts. By William Herschel, LL.D. F.R.S. —6. On a gaseous Compound of carbonic Oxide and Chlorine. By John Davy, Esq. Communicated by Sir Humphry Davy, Knt., LL.D., Sec. R.S.—7. A Narrative of the Eruption of a Volcano in the Sea off the Island of St. Michael. By S. Tillard, Esq., Captain in the Royal Navy. Communicated by the Right Hon. Sir Joseph Banks, Bart. K.B. P.R.S.—8. On the primitive Crystals of Carbonate of

of Lime, Bitter-Spar, and Iron-Spar. By William Hyde Wollaston, M.D. Sec. R.S.—9. Observations intended to show that the progressive Motion of Snakes is partly performed by means of the Ribs. By Everard Home, Esq. F.R.S.—10. An Account of some Experiments on the Combinations of different Metals and Chlorine, &c. By John Davy, Esq. Communicated by Sir Humphry Davy, Knt. LL.D. Sec. R.S.—11. Further Experiments and Observations on the Action of Poisons on the Animal System. By B. C. Brodie, Esq. F.R.S. Communicated to the Society for the Improvement of Animal Chemistry, and by them to the Royal Society.

The Twelfth Number of Leybourn's Mathematical Repository contains, 1. Solutions to the Mathematical Questions proposed in Number X.—2. On the irreducible Case of Cubic Equations.—3. New Properties of the Conic Sections.—4. Indeterminate Problems.—5. On the Ellipse and Hyperbola.—6. On the Roots of Equations of all Dimensions.—7. Properties of the Right-angled Triangle.—8. Continuation of Le Gendre's Memoir on Elliptic Transcendentals.—9. A Series of new Questions to be answered in a subsequent Number.

LXXIII. *Proceedings of Learned Societies.*

ROYAL SOCIETY.

Since our last Report, a paper by Mr. John Davy was read on some of the combinations of the fluoric principle. In this paper Mr. John Davy gave the results of some experiments on silicated fluoric gas and fluoboric gas, and described a new and more simple method of procuring this last gas; namely, by distilling together a mixture of dry boracic acid, fluor spar, and oil of vitriol. He stated the specific gravity of these gasses, and gave an account of their combinations with ammonia. Fluoboric gas combines in three proportions with ammonia, and with the largest proportions of the alkaline gas forms saline combinations, fluid at the common temperatures of the atmosphere.

A paper by Sir H. Davy was read, on some combinacions of phosphorus and sulphur, and on other objects of themical inquiry.

In this paper Sir H. Davy described pure phosphorous acid as a solid crystalline body, volatile at a moderate de-

gree of heat. He described a combination of this acid with water, likewise a crystalline solid, very combustible, and when decomposed by heat affording a peculiar elastic fluid absorbable by water, not spontaneously inflammable, and consisting of phosphorus united to two volumes of hydrogen condensed into the space of one volume, and which he proposes to call *hydrophosphoric* gas.

He entered into the detail of some experiments on sulphuric acid, which, he stated, cannot exist independently of the presence of water; and he described a solid compound of nitrous acid gas, sulphurous acid gas, and water. He considered all the facts advanced in this paper as affording confirmations of the theory of definite proportions. And he drew some general conclusions respecting the importance of water as a chemical agent. Most of the bodies called *oxides*, when precipitated from aqueous solutions, are in truth (said Sir H. Davy) hydrats; and their colours and their properties depend upon the combined water.

June 11.—Dr. Wollaston read to the Society a short paper on improvements in the camera obscura and simple microscope, founded on the same periscopic principles by which he improved the construction of spectacles a few years since *.

In his camera obscura the light is admitted through a circular opening to the concave surface of a large meniscus placed behind it, at such a distance that all pencils of rays pass nearly at right angles through its posterior surface. Hence those that come from objects obliquely situated, form more distinct images, and afford a larger field of view than is obtained by the common construction.

His microscope consists of two plano-convex lenses with their flat surfaces towards each other, but prevented from touching by a thin plate of metal. A small perforation in the centre of the metal suffers no rays to pass but what are at right angles to both the exterior surfaces, and hence give a distinct field of view of great extent.

He observes also that the camera lucida in its most simple form, with the upper surface of its prism concave, has the same advantage as the periscopic construction.

GEOLOGICAL SOCIETY.

May 1, 1812. The president in the chair.—A paper by Dr. M'Culloch (member of the Society), " On Bistre and

* Philosophical Magazine, vol. xviii. p. 165.

other

other substances produced in the distillation of wood; and on their analogy with the native Bitumens," was read.

When wood is submitted to destructive distillation, there is obtained, among other products, a black substance resembling common tar. This tar is very inflammable, and so liquid that it may be burnt in a lamp. By washing it with water either hot or cold, or submitting it to the action of lime or of the mild alkalies, a large portion of acetic acid is separated, and the residue becomes pitchy and tenacious. It is entirely soluble in caustic alkali, in alcohol, in ether, in acetic acid, and in the mineral acids. The fat oils and the recent essential oils dissolve but little of it; but if the former are made drying, and if the latter have become brown by keeping, they then act more readily and copiously. Coloured oil of turpentine takes up a considerable quantity, but naphtha only acquires a scarcely sensible brown colour by digestion upon it. When carefully distilled at a gentle heat it is decomposed into an oily matter, at first limpid and afterwards brown, a quantity of acetic acid combined with a little ammonia; and a spongy coal remains in the retort. In this process no inflammable gas is given out; but at a high temperature the oil is more or less decomposed, and an inflammable gas is produced, which, however, does not burn with a flame by any means so bright as the gas from pit-coal. If this destructive distillation is not carried very far, the matter in the retort will be found, when cold, to be solid, brilliant, shining, and possessed of a conchoidal fracture: its taste is burning and pungent, and its odour is that of wood smoke; it is fusible and readily inflammable. When kept melted in an open vessel till it ceases to be fusible, it becomes more and more brilliant, its fracture passes to splintery, and it assumes the perfect appearance of asphaltum. In proportion as it approaches this state it becomes less and less soluble in alcohol, and at length scarcely gives a stain to this menstruum. Naphtha has no action on it, and in this circumstance alone it differs from asphaltum. Dr. M. then proceeds to an examination of the Bitumens, and shows that the difference between the products of recent vegetable matter, and of the bitumens when subjected to distillation, consists in the former yielding empyreumatic acetic acid and a black pitchy matter insoluble in naphtha; while the latter afford ammonia and naphtha, but little or no acid. He then enters into a detailed investigation of the properties of the very important class of *Lignites*, or those sub-

stances, such as peat, surturbrand, Bovey coal, &c. in which the traces of vegetable origin are not obliterated.

Submerged wood from peat mosses gave a brown oil smelling of wood-tar, and refusing to dissolve in naphtha.

A compact pitchy-looking peat gave a fetid oil resembling in odour neither wood-tar nor bitumen, and very slightly soluble in naphtha.

Bovey brown coal gave an oil resembling in odour that of wood-tar, but much more soluble in naphtha: that portion of the oil which was insoluble in this menstruum had a strong odour of wood smoke.

The oil of jet was almost perfectly soluble in naphtha, and smelled strongly of petroleum; but it afforded also empyreumatic acetic acid.

Thus it appears that there exists a class of fossils of undoubted vegetable origin, which exhibit the gradual progress from wood to bitumen, and in which this change has been brought about by the action not of heat but of water.

The experiments, however, of Sir James Hall seem to show that heat with compression is also capable of converting wood into coal.—A critical examination of this fact was the next object of Dr. M.; and he found on heating wood in close gun-barrels that a black coaly-looking substance was indeed produced, but that it consisted wholly of charcoal, empyreumatic acid, and wood-tar, and did not contain the smallest portion of real bitumen. Hence the experiments alluded to do by no means prove the possibility of converting vegetable matter into real coal by mere heat. It appears however to Dr. M, that the consolidation of bituminized vegetables into coal is not unlikely to be the effect of subterranean heat.

The paper concludes by showing the identity of the pitch procured from the distillation of wood and the pigment called *Bistre;* and points out methods of obtaining it in a state better fitted than common bistre for the purposes of the artist; and also enumerates several other uses to which this substance may be œconomically applied.

Some notes on the mineralogy of the neighbourhood of St. David's, in Pembrokeshire, by Dr Kidd, (Prof. chem. Oxford, and member of the Geological Society,) were read.

The country about St. David's when viewed from an eminence presents the appearance of an extensive uneven plain, interspersed with numerous detached hills or rocky summits of an irregular conical-shape. The two highest of these

these hills are Penbury and Carn-Llidy, the western portion of the latter of which forms the promontory of St. David's-head.

These hills present no appearance of stratification, and are composed of feldspar and hornblend in various proportions and states of aggregation. They are each surrounded by mantle shaped strata of slate, elevated at a high angle, and presenting the characters of grauwakke-slate. This latter is traversed by veins of quartz, from which very fine specimens of rock-crystal are procured. No carbonate of lime appears to be contained either in the unstratified trap or in the slaty grauwakke; nor did there occur in them, with the exception of one equivocal instance, the smallest trace of any organic remain.

May 15. The president in the chair.—An account of the island of Teneriffe, by the hon. Henry Grey Bennet, (member of the Geological Society) was read.

The greatest length of this island from north to south is about seventy miles, its greatest breadth does not exceed thirty miles. In the south-western part of the island is situated the mountain called by the Spaniards El Pico di Tiede, but better known by the name of The Peak of Teneriffe, the height of which, from the mean of several observations, appears to be about 12,500 English feet.

The rocks and strata of this island appear to be wholly volcanic. A long chain of mountains passes through the interior, sloping on the eastern, western, and northern sides to the sea, but on the S. and SW. elevated into nearly perpendicular mountains which are intersected by deep and narrow ravines.

The lowest bed of the island is porphyritic lava composed of hornblend and feldspar, in its upper part porous, scoriform, and sometimes passing into the state of pumice. Upon this rests a bed of the same substances as already mentioned, but in structure nearly approaching to greenstone This is covered by a thick bed of pumice, which itself is overspread with basaltic lava, on which in many places rest beds of tufa and volcanic ash.

This basaltic lava decomposes sooner than any of the other rocks, and contains the greatest variety of imbedded substances: it is sometimes divided by a layer of olivine in crystals some inches long, and is often intersected by thick veins of porphyritic slate. Zeolite and chalcedony also occur in it.

The number of small craters and extinct volcanos is prodigious:—they are to be found in all parts of the island,

 but

but none of them have been in activity of late years. The great streams of lava have flowed from the peak: those of the years 1704 and 1797 (which was the last) are basaltic. This latter flowed so slowly, notwithstanding the sharp descent of the mountain, that it was several days in advancing three miles. On the south-western side of the peak is an ancient lava not at all decomposed several miles in length, and in a perfect state of vitrification resembling obsidian.

June 5. The president in the chair.—Lord viscount Valentia and W. Franklin, M. D. were elected ordinary members.

"An account," by Thomas Webster, esq. (member of the Geological Society,) "of some new varieties of Alcyonia, found in the Isle of Wight," was read.

In viewing the rocks about Ventnor Cove and in various parts of the undercliff, Mr. Webster remarked, in the sandstone stratum immediately under the chalk-marl, a great number of small prominences resembling in form the branches of trees. They were of various sizes, from half an inch to three or four inches in diameter: their substance was sandstone of the same kind as the rocks they were in; but the part resembling the bark was somewhat harder, which enabled it to endure longer than the rest of the stone, and thus project above its surface. Some of them were straight, others a little crooked, and in a few instances he observed them forked. He found fragments of these bodies in every part of the island where the sandstone stratum can be seen, and particularly among the masses of rock lying under the cliffs of Western Lines. In this last place he found that the stems above described had frequently heads or bulbous terminations attached to them, in form somewhat resembling a closed tulip, and in some of these he found distinct traces of organic structure, from which it appeared that these heads consisted of a group of *tubuli* now converted into and enveloped with stony matter. Besides these extraordinary shapes which projected in relief, Mr. W. observed a variety of very regular white figures as if painted upon the rock, being even with its surface. They consisted of circles from two inches to half an inch in diameter, ellipses of various eccentricities, and parallel lines both straight and crooked.

By a careful examination Mr. W. found that these white figures belonged to the other class of bodies already described; that the cylinders were only the internal parts of the same body, whose various sections formed the white circular and elliptical figures. The vast masses of rock which have fallen down, having separated from the cliff at the divisions between

between the beds, showed their upper and under surfaces covered with layers of these bodies heaped upon each other and lying prostrate in every possible direction; and in the joints between the beds where they were not separated, they were distinctly seen.

The green sandstone and the limestone he found to be the chief repositories of these bodies. In the ferruginous sand below the green sandstone he found none, and only a few fragments of cylinders in the blue marl on which the sandstone rests. He traced them upwards into the chert; but they there became rare, and they totally disappeared in the chalk-marl.

He found them, however, frequently in the fragments of flint lying on the shore. Mr. Webster having brought away an extensive series of specimens (which he has since deposited in the collection of the Society), submitted them to the examination of Mr. Parkinson, who is of opinion that they belong to the genus Alcyonium, but that they are of three or four different species, neither of which have been hitherto described. From the resemblance which these bodies bear to a closed tulip attached to its stalk, Mr. W. suggests that the name of *Tulip Alcyonium* may be not improperly applied.

"Some observations," by James Parkinson, esq. (member of the Geological Society,) "on the specimens of Hippurites from Sicily," presented to the Society by the hon. Henry Grey Bennet, (a member) were read.

These specimens Mr. Parkinson considers to be such as demand particular attention, as they possess those characters which will probably serve to correct some erroneous opinions respecting the nature and habits of the animals of which these shells were the dwellings.

One of the specimens contains a nearly perfect shell, longitudinally divided so as to display the two ridges with the numerous septa and chambers.

From an examination of these specimens, and by comparing them with the observations he has before had an opportunity of making, Mr. Parkinson is of opinion that the structure of the shell of the Hippurites is such as would enable the animal to raise itself to the surface of the water.

This opinion is in opposition to that of M. Denys de Montfort and most of the French oryctologists, who consider the Hippurites as belonging to what they term pelagian shells, or such as constantly inhabit the bottom of the sea, never rising to the surface or appearing on the shores, and therefore that there is no reason to believe them as be-

longing

longing to animals which are now extinct, but only that their recent analogues have not yet been brought to view.

June 19. The president in the chair.—Charles Bell, esq. F. R. S. E., Daniel Moore, esq. F. R. S. &c., and the Rev. Edward Slater, were elected ordinary members.

A paper by Joseph Skey, M. D. entitled "Some remarks upon the structure of Barbadoes, as connected with specimens of its rocks," communicated by Arthur Aikin, esq. secretary, was read; together with a Note by Mr. Parkinson on some of the specimens presented by Dr. Skey.

The island of Barbadoes is totally unlike those immediately near it, both in appearance and in structure. The land rises in a gentle swell from the coast towards the middle of the island, except in one small district. Its highest hills do not exceed 800 or 900 feet, and their general direction is nearly NW. and SE. Upon the north-eastern coast the shores are bolder than in the other parts of the island, as is the case in many of the islands of these seas.

Barbadoes is composed of limestone, in great part of fossil madrepores, and traces of organic structure are to be met with in almost every part of the island, more particularly along the whole of the S. and SW. coast.

The land which when seen from the sea appears to rise uniformly from the coast, is observed on a nearer view to consist of successive terraces rising in two or three gradations, one above the other, each forming a plain of a quarter or half a mile in breadth, and terminated by a cliff of coral rock varying in elevation from twelve to twenty feet, and sometimes considerably higher.

Deep fissures have in many places of the island rent asunder the cliffs, and these gullies (as they are called) are continued across the terraces in irregular lines. Numerous caves are every where to be met with, and they are sometimes of very large dimensions.

On the S. and SW. side of the island there may be seen at very low water a bed of calcareous sandstone dipping SW. thirty degrees. To the eastward of the garrison of St. Ann, there is found a dull compact chalky-looking limestone with ramose alcyonia, while considerably to the westward the rock is more distinctly coralloidal.

Upon the northern and north-eastern side of the island is a small mountainous district called Scotland. It consists almost entirely of limestone, but of a kind less marked by organic remains than in the other districts.

In Mr. Parkinson's Note it is observed that some of Dr. Skey's specimens illustrate the nature of some fossil corals; showing

showing that the forms in which they at present exist, are not those which belong to those substances in their original state, and consequently ought not to affect their specific or generic distinctions.

A letter from E. L. Irton, esq. describing some remarkable tubes found in the drifted sand at Drigg in Lancashire, was read; together with an account, by W. H. Pepys, esq. (Treasurer G. S.), of a chemical examination made by him of the substance of these tubes.

These tubes are nearly in a perpendicular position, imbedded in the midst of the hills of drifted sand, on the sea shore, without any communication with the surface; and there are ramifications extending from them which generally point downwards and terminate in fine points. The tube sent to the Society is above an inch in diameter, and of an irregular form: the outside consists of black and white sand agglutinated together; the inside is smooth, and has a vitrified appearance. When dug out of the sand it was soft, and in some degree flexible; and the inside coating at its first exposure to the air was soft to the touch and rather unctuous; but in less than a quarter of an hour it hardened into the state in which it now exists.

The tube when found was filled with the sand of the hill, and that sand is quite different from the sand of which the outside of the tube consists.

Both the sand and the vitreous part of the tube scratch glass; and on the latter, when viewed by a lens, there are seen small air-blebs, such as are common to imperfect vitrification. Both are insoluble in sulphuric and nitric acids; infusible before the blowpipe without addition, and partially fusible on the addition of boracic acid; but with soda a complete fusion took place, and the residue was nearly soluble in water.

A paper by Dr. M'Culloch (member of the Society), "On the vitrified Fort of Dun MacSniochain, near Oban in Argyleshire," was read.

In the discussion which some time ago took place respecting the vitrified forts of Scotland, the question on which the two contending parties were most at issue, was, whether the vitrification was the effect of design or of accident.—It occurred to Dr. M. that light might be thrown on the subject by examining with mineralogical accuracy the substance of which these structures were composed, and noting the changes which each had undergone in consequence of the fire, and also by observing whence the stones had been derived which were used in them; and that the question

question of accident or design might be illustrated, by examining in the laboratory the degree of heat required to produce the appearances in the stones which actually existed in these structures.

The fort of Dun MacSniochain stands on a long narrow hill, which is nearly precipitous along three parts of its circumference, and at the other end it rises from the plain with a very accessible acclivity. The walls, which are all at present buried under the soil, are about eight or ten feet in thickness. They bear marks of vitrification through their whole extent; but in no case does it appear to have extended more than a foot or two upwards, and the most perfect slags are found at the bottom of the foundation. In the higher parts of these are stones roasted by the action of the heat, but unvitrified, and at length the marks of fire almost entirely disappear. The hill consists of alternate beds of schistus and limestone, but the latter is the predominant rock.

It is perfectly insulated in a great alluvial plain. The mountains of Benediraloch, which bound the plain to the west, consist of granite gneiss, mica-slate, quartz and porphyry. On the edge of these rocks are found large detached masses of puddingstone, consisting of rounded pebbles of greenstone of different varieties, of amygdaloid and quartz cemented by a paste which appears to consist chiefly of trap sand, united by the hard variety of calcareous spar. The paste contains also in small quantity zeolite, prehnite, garnet, and diallage. This puddingstone where nearest the fort is at least half a mile distant from it. The walls of the fort consist principally of granite gneiss, mica-slate, clay-slate quartz, puddingstone and pyritical slate entangled together with a very small proportion of the particular rock on which the fort itself is founded: puddingstone forming the greater part of them. This puddingstone Dr. M. shows to be the only vitrifiable ingredient of the walls; and from the distance from which it must have been brought, and the great quantity of it employed in the work, he considers it probable that the builders of the fort must have been acquainted with its vitrifiable nature, and that it was on account of this quality that they had employed so great labour in transporting it. For if their object had not been to produce vitrification, but merely to erect a dry wall of stone, the limestone of the hill would have answered their intentions, or perhaps the loose stones of the adjoining plain.

That they did not obtain the puddingstone from the latter

latter source, is evident; for although the plain and shore are covered with fragments, these consist almost entirely of the primary rocks: and besides the pieces of the wall which have not felt the fire, there are angular fragments, showing pretty clearly that they were not collected on an alluvial plain, but broken from the rocks where they are found.

Dr. M. next proceeds to describe the various states in which the different stones are found.

The puddingstone exhibits the greatest variety of changes. It is found in every state, from a black glass to a spongy scoria capable of floating in water, sometimes exhibiting the gradual succession of changes from incipient calcination to complete fusion. To ascertain the degree of heat necessary to produce the corresponding changes in this rock, Dr. M. submitted various parts of it to the furnace, and found that some of the fused substances must have been brought to that state in a heat not less than 100° of Wedgwood's scale; a heat at which many varieties of earthen-ware are baked.

Dr. M. next gives a short account of the vitrified fort of Craig Phadric in Invernessshire, and of another in Galloway; in both of which, but more particularly in the former, he observed circumstances quite analogous to what he had already found at Dun MacSniochain; and the conclusion he has been led to form is, that the vitrification of these forts is the effect of design.

The Society adjourned till November.

RUSSELL INSTITUTION.

May.—In the fourth Lecture Mr. Bakewell proceeded to describe the stratified rocks containing rock-salt and coal. The coal districts in England and in other parts of the world, he said, were generally separated from the compact limestone which contains metallic veins, by thick beds of coarse grit-stone and sand-stone, in which some vegetable remains first make their appearance. In the midland counties of England, there are two kinds of rock interposed between the coal and the lime, forming together a mass of three hundred yards in thickness. The lower bed consists of a dark reddish-brown shale, in which strata of micaceous sand-stone and beds of dark limestone occasionally occur. The upper rock was called by Mr. Whitehurst mill-stone grit, from its containing beds of hard siliceous grit-stone, used for mill-stones. This rock varies both in colour and quality

quality in different parts. It was first observed by Mr. Whitehurst that under this rock no coal is ever found. This observation Mr. Bakewell said was correct, as applied to workable coal, or such beds that were of sufficient thickness to be got with profit; but very thin seams of coal, as well as vegetable impressions, are not unfrequent in these rocks. They extend over a considerable part of the northern counties, and form the range of central hills from the north of Derbyshire to Craven in Yorkshire. Mr. Bakewell said he was inclined to believe that the lower bed, a dark-brown shale, changed its quality as it passed into Cheshire, and was there the red sand rock of that and the adjacent counties. He observed that he did not consider some difference in external character alone sufficient to disprove the identity of strata which may spread over a large tract of country. In this red sand rock the rock-salt of Cheshire is found. He described the various repositories of salt in Spain and different parts of the world, and observed, that it had been found at the height of 9000 feet above the level of the sea; and from its position, as well as from the difference of its constituent parts from those of sea-salt, he was inclined to believe that it had not been formed by the evaporatoin of sea-water, as some geologists have asserted. The rock-salt of Cheshire is remarkably free from impurities, containing, according to the correct analyses of Dr. Henry, not the least sulphat of magnesia, and not one grain in 1000 of muriate of magnesia. In the same quantity of sea-salt not less than 46 grains of these two saline impurities occur.

In the strata over these rocks we meet with beds of coal occupying distinct districts called coal-fields. Mr. B. then described the various kinds of stone-shale, and iron-stone, that alternate with coal, and the appearances which offer indications of its presence. The position into which coal strata are thrown by faults and dykes in different parts of England were explained by drawings and sections. A most singular elevation of a bed of coal in the vicinity of the red rock in Lancashire was particularly noticed. Where this rock comes nearly in contact with the coal, the stratum is raised up vertically, whilst seven other beds of coal in the same field are all inclined at an angle of 25 degrees. Mr. Bakewell stated, that he had communicated an account of this coal-field to the Geological Society, as he conceived that it might lead to some discoveries respecting the geological relations of the red sand rock with the coal strata. The obstacles which impede the working of coal-mines from

from the fire- and choak-damps were described. The nature and properties of these noxious vapours were illustrated by experiments, and some account given of the different modes of clearing the mines in different districts.

Mr. Bakewell observed, that Dr. Miller and other writers on the coal districts of England had entirely overlooked the coal of the West Riding of Yorkshire, although the quantity procured there supplied a population nearly equal to that of London, besides the extensive manufactories of that county. He described the manner in which the quantity of coal in the coal-fields of Northumberland and Durham had been estimated; from whence it appeared that at the present rate of consumption they would be entirely exhausted in the space of three centuries. Were there no other repositories but these, he observed that it would become the duty of a wise statesman to prevent exportation to foreign countries, and to plant all our waste lands, and provide against impending though remote calamity. Let any person, said he, reflect on the condition of the metropolis were it deprived for three months of the supply of coal. All the wood in the country would be destroyed, our manufactories would be annihilated, and a scene of national calamity would ensue, of which we can scarcely form an idea.

But besides extensive coal-fields in Yorkshire and other parts of England, at present scarcely touched, there exists a great repository in South Wales of one thousand square miles of coal, which, from the thickness of the different strata, he calculated would supply the consumption of Britain for several thousand years to come, estimating that consumption at twelve million tons annually. He concluded by giving a short outline of the coal districts in different parts of the world, and the periods at which coals appear to have been introduced for fuel. It may excite a smile, said he, at the ignorance of our ancestors, to find an act of parliament in the reign of Elizabeth, prohibiting the burning of coal in London during the sitting of parliament; but probably posterity at no distant period may look with equal surprise at the general indifference evinced by landed proprietors of the present day, respecting the mineral substances on their own estates.

LONDON PHILOSOPHICAL SOCIETY.

[Continued from p. 395.]

Mr. Clarkson next proceeded to investigate the characters of moral existence, observing, that pathognomy had already

already proved its action, and anatomy the effects of its action, in the second division of the face. All that was necessary, therefore, was an ideal standard, by which to judge of the moral or immoral propensities of the individual, and this the Greeks had already erected. Their statuaries had two objects in view; one of which was to eradicate all violent passions from the faces of their deities, (and this they effected by reducing and softening down the muscles of the cheeks and nose,) and the second was to leave upon their faces the character of some quality for which they were distinguished, (and this they effected by strict physiognomical rules.) He then detailed the different physiognomical expressions of the ancient gods;—the sentimental laxity of Venus, the purity of Diana, the fortitude and taste of Minerva, the pride of Juno, the benevolence of Apollo, and the conscious calm security of Hercules,—all of which he proved by drawings and busts of the antique physiognomically exprest; nor could his conclusions, he said, be denied without a ridiculous dilemma, that the head of one deity would have answered as well for another. We need look no further, then, for a standard for the nobler propensities of our nature. Nor were the characteristics of the ignobler less apparent to investigation. Drunkenness and every species of intemperance distort and caricature the face in proportion as they destroy the intellect and the sentimental emotions—and here the Lecturer alluded to the head of Nero at the Museum, asserting that it was impossible to contemplate that head without recognising in it the intemperance, the gluttony, the pride, and impiety of that sanguinary monster. Originally handsome, every thing proclaimed the lapse of the man into the brute: the elevated chin, the swollen throat, and depending cheeks, the breathing nostrils, and staring eyes, spoke a language not to be mistaken.

Mr. C. next adverted to the contrast observable in the faces of Cupid, or Venus and Minerva. It was as evident as the contrast between ambition and love, the master-passions of human nature. In the former, the cheeks are rotund; in the latter, concave;—in the former, the nostrils are dilated, in the latter, rectilinear and compact;—the interval, therefore, affords a standard to judge of the mixture of these passions in the individual. But the Greek head of Pan, the lecturer observed, was a kind of silent physiognomical lecture. No one will pretend to say that it does not express passions in quiescence, and no one can doubt the nature of the passions it conveys.—The diagonal bearing

bearing of the eye, the brutal projection of the mouth, the lapse of the eyebrows and nose, and the complete distortion of the latter characteristic; express a total debasement and abandonment of the mind. If, then, we assume the face of Pan as the lowest state of sensual degadation to which man can fall, as the boundary which separates him from brutes, and assume the unpolluted face of the Greek ideal as the shade which mingles him with gods, we obtain another standard to judge of moral brutalization or refinement.

We are sorry that our limits will not allow us to follow the lecturer through a masterly analysis of the passions, their physiognomical effects, and their modification by the different temperaments of the body, whether phlegmatic, sanguine, or melancholic. We have stated enough in detailing his remarks on Greek statuary to render his object lucid and practicable,—the erection of a standard for moral propensities as well as intellectual energies.

Animal life and its territory was the last division of his subject. Its indications, he said, were extremely simple, and easily explained. All relaxation is accompanied by a separation of the jaws—total debility is accompanied by a total laxity of the under-jaw, the extreme of which is death. Firm strength is designated by a firm closure of the teeth, the last extreme of which is the elastic unnatural animal power, which imparts its convulsive violence to madness, and which, as well as anger, classically called a short madness, is expressed by a vehement compression of the jaws or gnashing of the teeth. A rectilinear chin, said Mr. C. like a rectilinear forehead, is the ideal standard. All great philosophers have possessed an angularity of chin. Gluttons, and men who sacrifice intellect to sense, the contrary. The chins of the fair sex are always smaller and chaster in their form than those of men. A chin that projects, unless beyond a certain point, displays animal strength; that which recedes, animal deficiency. The same rules, therefore, which apply to the forehead apply to the chin. Nor is the mouth a less strong hieroglyphic than the eyebrow. Every one is aware of the distortion to which contempt and sensuality subject the mouth; but there is a more general and universally applicable axiom depending on this subject, for the forehead of brutes is not more dissimilar from that of man than their mouths. The intermediate degrees between them are pregnant with the same deductions. A scale, therefore, may be applied to all the gradations of character in the human face; and if a scale, the

 ground

ground plot for the elevation of physiognomy as a portion of the great scientific fabric is marked out and arranged.

Mr. C. then descanted on the benefits which would result from thus reducing physiognomy to something like a regular science; for man, as he is at present constructed, will and must form some physiognomical opinions; and it is surely much better that he should form them upon scientific principles, than on the vague suggestions of fancy or association. But Mr. C. protested against an individual assuming the right of judging his neighbour's character in the present imperfect state of the study, or without long initiation. When, however, certain pathognomical indications coincide, a very accurate judgement may certainly be formed by a student who has refined his perception of character by experience as well as rule. These indications may be discovered in the regular or irregular walk, in the erection or depression of the head, in the shortness or length of the neck, in the steadfast or wavering look of the eye, when the individual is engaged in conversation; in the attitude or gestures, whether violent or relaxed, of the speaker; in the sound of the voice, whether base or treble; in the address, whether open, imposing, or retiring; and lastly, in the first words uttered on acquaintance. Mr. C. concluded by an interesting argument on the physiognomical effects of education, and the drama, which afforded us a degree of pleasure invariably our attendant when listening to his ingenious inquiries.

LXXIV. *Intelligence and Miscellaneous Articles.*

EARTHQUAKES AND VOLCANIC PHÆNOMENA IN THE WEST INDIES.

In the short space of time between the 26th of March and the 2d of May last, a succession of dreadful physical events has demolished some of the finest cities in South America, and shaken several of the islands to their foundations, wasting them with fire, and covering them with ashes and dust. The General commanding the troops of Coro de Domingo Campo Verde writes to the Governor of the province of Coro, that the city of Barquisimeto was on the 26th of March buried in ruins by a most dreadful earthquake. And he communicates the following moral event, which immediately succeeded. The inhabitants of the district, conceiving the phænomenon to have been an immediate manifestation of divine displeasure for having re-

belled

belled against their sovereign, returned to their allegiance. "All the villages," says the General, "belonging to this district and the city of Jouyo, with the greater part of the villages belonging thereto, have come and offered submission under the banners of Ferdinand VII." and subsequently adds, "By the panic and terror with which the inhabitants are struck since the earthquake, I have no doubt that the army of Coro will eventually conquer the province of Venezuela."

During this terrible commotion of the earth, which appears to have broken out at intervals between the 26th and 28th, the following cities were destroyed in the province of Coro: Barquisimeto, totally destroyed; Arilaqua, sunk; Santa Rosa, also sunk; Caudare and Phelipe, destroyed; and St. Charles and Caramaoate greatly injured. In the province of Caraccas, the same calamity has been equally tremendous. The cities of Caraccas, Victoria, Valencia, Porto Cavello, Laguira, New Barcelona, Maiquetia and Cumana have been almost entirely ruined.

The same or similar subterranean causes, which have so severely desolated the continent, about the end of April manifested their influence among the West Indian islands: and the following letters furnish several interesting and affecting circumstances.

Extract of a Letter from Barbadoes, May 2.

"As far as I can relate, I will give you a true account of a most awful event, as witnessed and experienced by myself.

"I was lying in bed about six o'clock in the morning, when I observed my chamber more dark than usual. Some time after I arose and opened one of my windows, when I observed to the north a dark thick cloud, similar to the usual indication of a great deal of rain (which would have been very acceptable); but at the same time I perceived a most remarkable bright cloud to the southward; so much so, as to reflect light on the houses. We had had what we conceived to be several rolling claps of thunder during the night, and the last was a quarter past seven, when an instantaneous total darkness ensued, and from that time till one o'clock I never saw so dreadful a phænomenon. I never beheld so dark a night in the gloomy month of November: in short, every thing appeared like chaos, and the lamps, handed about the streets in hundreds, were scarcely sufficient to give light to the persons who held them, much less to any one else. To paint the horror of the scene is utterly impossible. During the time of the darkness we were assailed by immense falls of calcareous matter (as I think) to such a degree that it was dangerous to go out

out of the house: indeed it was impracticable to do so without a hood or umbrella; and these were only temporary screens, for by the time you had proceeded one yard you were completely covered by this stuff.

"At ten o'clock the rev. Mr. Garnett had the church bells rung, and gave prayers: but such a scene of horror, dismay, terror, and consternation, cannot be imagined by one who did not see it. Thousands of people of all descriptions flocking to church, without rank or distinction, mistress and servant kneeling and praying by the side of each other, all fearing some dreadful catastrophe would hurry them out of the world before they could make their peace, and firmly believing they should never see the light again. I must confess to you I gave myself up, for the lava was gathering very fast on us, and no prospect but of starving or perishing under it. At first what fell was a large black substance, very coarse, but it gradually became as fine as Scotch snuff, and in a few hours the streets and the tops of the houses were many inches thick in this matter.

"About half past one o'clock a small glimmering of light began to appear, and by half past two o'clock we could make out people in the streets. It then gradually got lighter, so that we could see volumes of this matter floating in the air, but so thick as still to obscure the sun, nor have we yet seen the sun clearly. About half past six last night we saw like rays of fire in the southern quarter again. From all these circumstances I am led to think there must have been an explosion of some volcano very near us. To-day we have been busy in endeavouring to remove the lava, but I much fear, without we have a heavy fall of water to assist us, we shall be very long about it, and God only knows how it will end. The whole island is in one complete sheet of lava; the canes are all weighed down with it, and the poor cattle and horses must die for want if we are not immediately relieved. We cannot see twenty yards before us for the immense volumes of this stuff continually falling from off the tops of the houses; for so soon as it is dry, it is exactly like flour. I am inclined to think now, the thunder I thought I heard in the night was the explosion of some volcano. I herewith have sent you some of this dust, which I hope you will receive safe."

To this we subjoin the account that has reached us from St. Vincent's, where a volcano which had long been quiescent has broken out with extraordinary violence.

Extract of a Letter from St. Vincent, May 6.—"Having been informed that you had not sailed from Grenada by the April fleet, I hasten to give you some account of a most alarming circumstance which took place here last night

and this morning. About sun-set, on Thursday evening, we observed an immense quantity of fire and smoke to proceed from the volcano, and continued till one o'clock this morning, when a most tremendous explosion took place, and continued till four, throwing up immense quantities of stones and ashes all over the island On the estates in the vicinity of the mountains the ashes are said to be from two to three feet deep; that two of the principal rivers have been dried up, and new ones formed; and that many of the estates in that quarter have been much injured. One white person and six negroes have been killed. Although Kingston is at the distance of about twelve miles from the volcano, the inhabitants were so much alarmed, that many of them went on board of the vessels in the bay for protection, and it was not until past 8 o'clock that one person could distinguish another, in consequence of the atmosphere being darkened by the quantity of ashes. I am much afraid that the extent of the damage sustained is not yet known."

A second Communication from Mr. William Moore, *on the Use of Oxymuriate of Magnesia in Bleaching.*

To Mr. Tilloch.

Sir,—Since my former communication to you, I have received a letter from my brother (Mr. J. W. Moore, of Dublin), inclosing a copy of a letter he received from Mr. John Duppy junior, relative to the use of oxymuriate of magnesia by that enlightened gentleman in his manufactory near Dublin.

I will thank you to add it (if possible) as an appendix to my former paper on this subject*: it is as follows: "I have used the oxymuriate of magnesia on the large scale, ever since December 1810, and since then have been daily extending the application of it. To the communication I made Mr. Davy on this subject, I do not feel I could add any thing further, unless in generally stating my since experience, as confirming its superiority over the oxymuriate of lime for whitening the grounds of *delicate dyes*, such as yellows, madder reds, &c."

The inaccuracy of Dr. Ogilby's statements are still further confirmed by this second letter of Mr. Duppy's; and although I did not entertain a doubt as to their fate in the scientific world yet they might deter the manufacturer, from adopting these improvements. Under these impressions I have been induced to trespass on your indulgence.

I remain with respect, Your much obliged,

London, 25th June, 1812. Wm. Moore.

* This communication reached us too late for insertion in the form wished by the author.

Copper and Manganese.—In the hill about a mile north of Stapleford, in Nottinghamshire, consisting of Gravel Rock, very similar to that of which Alderley-Edge NW of Macclesfield in Cheshire is composed, but not resting on and surrounded by Red Marl as that Hill does, but on and by Coal-measures, a vein of Ore of Manganese, Iron, and Copper, with much Mica, was lately discovered, on the Estate of Admiral Sir John Borlase Warren, Bart., who has caused some of the Ore to be smelted and the copper refined, which proves to be of the very best quality. Sir John had a Coal-seam seven feet thick lately in work, about 300 yards S of this mine, and has proved the same Coal-measures at about 4 or 500 yards N, while Lord Middleton's large Collieries in Trowel are not more than 800 yards distant, in the same direction.

Meteorological Observations made at Clapton in Hackney, from May 21, to June 20, 1812.

May 21.—W.S.W. Cloudy morning; afterwards rain, and long showers; fair, but damp evening: various clouds in the lucid intervals.

May 22.—N. Cloudy in the morning. Fine afternoon, but very cold with *scud*, and irregular masses of *cumulus* and *cumulostratus*.

May 23.—N. Features of various modifications in different heights. Fair day.

May 24.—Clouded day; in some places a wavy, in others a mottled appearance of the sky: a little rain fell during the day.

May 25.—W.S.W. Small rain kept falling almost the whole of the day, but held up in the evening, which became fair.

May 26.—Fine warm morning; *cirrus, cirrocumulus* and *cirrostratus* in different altitudes, approaching to *cumulostratus* here and there; and a sort of partial haze of a brownish colour floated gentle along in the south west. Wind very calm.

May 27.—S. Fine warm day; *cirrus, cirrocumulus, cirrostratus* and *cumuli* irregularly disposed.

May 28.—S. Clouds in two strata, followed by a fine warm rain in the evening. The sun appeared just as it was setting, over a *cirrostratus* in the horizon; it appeared deep golden red, and threw a fine crimson blush on a *cirrostratus* thinly diffused in a higher atmosphere.

May 29.—S. All the modifications of cloud appeared

in

in different stations, and fine petroid *cumuli* in particular prevailed: slight showers in the course of the day: thunder showers at night.

May 30.—Fine day; some lofty *cirrus* cloud and scud below sometimes appeared, but in general the clouds were of one character, particularly in the afternoon, being compact, but rather rocky *cumuli*.

May 31.—Clouds in two strata, followed by nimbification; generally cloudiness by night with rising wind.

June 1.—S.W. Rainy morning, but the rain was generally small. Evening irregular features of different clouds, and sun at intervals. Fine clear night.

June 2.—W.S.W. Clear very early, then the sky became obscure; *cumuli* rose and general cloudiness prevailed: the day, however, became fair with various clouds.

June 3.—S.W. Clouded morning, followed by some rain; fair afternoon; the higher masses of cloud in different strata put on the character of *cirrocumulus;* indeed among others that kind of large and clear feature of this cloud appeared which I have remarked to attend warm and healthy weather: *cirrostratus*, *cumulostratus*, &c. appeared. Night very clear.

June 4.—S.W. Fine warm day, with diurnal *cumuli*, and some features of the other modifications; the clouds increased in the evening, but the night was fair.

June 5.—W.S.W. Fine clear morning; in the day appeared *cumuli;* evening *cirri* appeared aloft scattered irregularly.

June 6.—Fine day, with *cumuli;* in the evening fine clear sky and beautiful yellow sunset, with lofty *cirri* scattered about, which became tinged with crimson.

June 7.—S.E. Clouds early; fine clear dry day, with only a few little irregular *cumuli* here and there.

June 8.—N. Cloudy in the morning; sun out by times in the day. Cloudy night again, and cooler than hitherto.

June 9.—N.W. wind prevailed; the morning was cloudy, the day became warm and fair, with masses of *cumulus* and some streaks of *cirrus;* in the evening *nimbi*, but no rain fell hereabouts.

June 10.—N—E—SW. Sun and clouds in the morning; cloudy evening, and rather warmer again towards night.

June 11.—Fair day; some features of loose *cirrocumulus* early; *cirri* scattered above, floating *cumuli* below prevailed all day; the *cirri* in the evening became denser and coloured by the setting sun, and were accompanied by some *cirrostrati*.

June

June 12.—Clouded morning; *cumuli*, &c. per day; fine evening; feature of *cirrostratus*.

June 13.—W.S.W. Fine morning very early; about four o'clock I observed features of *cirrocumulus*, *cirrus*, &c. by about eight a mist, which had been coming on slowly, became thick, and the sky clouded; the afternoon was fair with much cloud. The evening clear, except some *cirri* and *cirrostrati*.

June 14.—SW—W. Very early the *cirrus* appeared breaking out into various and beautiful *cirrocumuli*, and lower some *cirrostratus* seemed scattered along; the wind was quite calm, and the day became hot; *cumuli* sailed under the above clouds; *cumulostratus* formed, but subsided; the evening was clear, except *cirri* fibrous and ramifying about in many directions and coloured by the setting sun *.

June 15.—W.S.W. Fair day, with irregular features of several modifications in different altitudes; the quantum of cloud increased in the afternoon, and wind rose.

June 16.—S.W. Before light a hard shower, *cumulostratus* prevailed; fair afternoon with rows of plumose *cirri*, &c.

June 17.—S.W—S. Very early *cirrus* confused and plumose with diverse kinds of loose *cumuli*; then *cumulostratus* and hard showers, which prevailed all day; fair evening.

June 18.—W—S.W. Fair morning, clouds in different altitudes; rainy evening and night, with pretty strong wind.

June 19.—S.W. Wind and rain, which continued all night; also remained this morning: the day however became fair with *cirrus* and *cirrocumulus* aloft, and *cumuli* under nimbification commenced again in the evening with wind.

June 20.—S.W. Showery, and rather windy all day. Fine evening; confused *cirrus*, *cumulostratus*, &c. as usual, between two *nimbi*.

Clapton, June 21, 1812. THOMAS FORSTER.

* While the obliquely descending and angular fibres of the *cirrus* appeared to be equalizing the electricity of the surrounding air, they were also carried gently forward by the wind: this shows that wind may pass through a mass of atmosphere without destroying the inequality of its electricity, which is slowly effected by the agency of its proper conductor, the *cirrus*.

METEORO-

METEOROLOGICAL TABLE,

BY MR. CARY, OF THE STRAND,

For June 1812.

Days of Month.	Thermometer. 8 o'Clock, Morning.	Noon.	11 o'Clock Night.	Height of the Barom. Inches.	Degrees of Dryness by Leslie's Hygrometer.	Weather.
May 27	62	73°	62°	29·56	55	Fair
28	60	66	63	·57	0	Rain
29	60	72	61	·55	56	Fair
30	61	70	60	·82	60	Fair
31	60	70	59	·75	48	Fair
June 1	56	62	55	·78	0	Rain
2	55	67	52	·98	60	Fair
3	56	60	53	30·00	0	Rain
4	60	70	56	·04	57	Fair
5	61	69	54	·05	50	Fair
6	52	64	50	·10	46	Fair
7	53	65	52	·16	49	Fair
8	53	61	50	·22	53	Fair
9	51	60	55	·21	50	Fair
10	50	57	48	·28	46	Cloudy
11	55	70	62	·20	59	Fair
12	62	72	60	·03	65	Fair
13	59	70	62	29·94	60	Fair
14	60	74	61	·84	65	Fair
15	63	69	59	·82	45	Cloudy
16	56	65	52	·56	46	Fair
17	52	55	50	·45	0	Rain
18	51	62	49	·79	27	Cloudy
19	52	57	50	·34	36	Stormy
20	54	60	49	·37	40	Stormy
21	52	58	50	·52	10	Stormy
23	55	60	50	·89	35	Showery
24	51	63	54	·90	37	Showery
25	53	66	54	·80	32	Showery
26	53	52	48	·50	0	Rain

N.B. The Barometer's height is taken at one o'clock.

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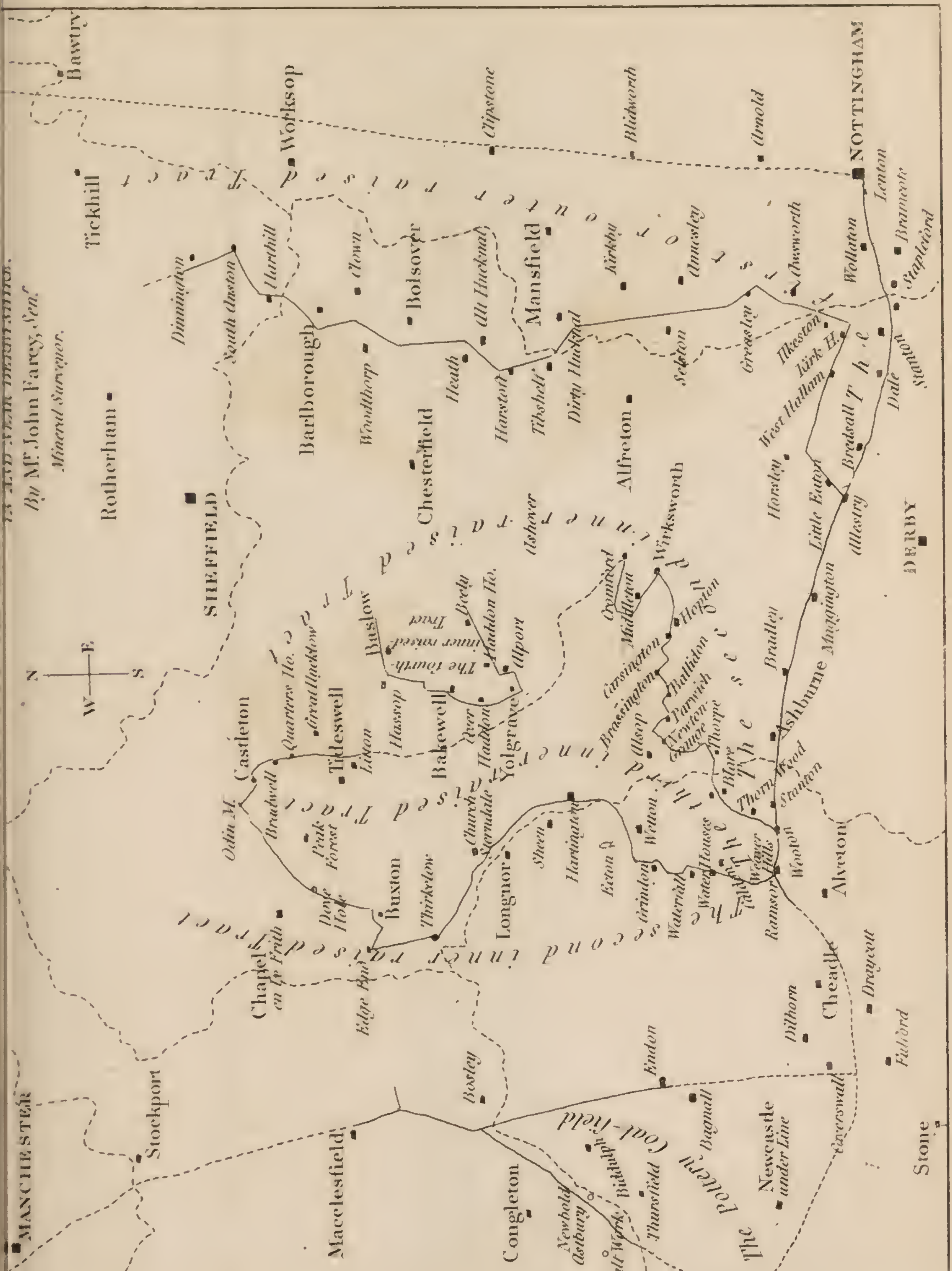
END OF THE THIRTY-NINTH VOLUME.

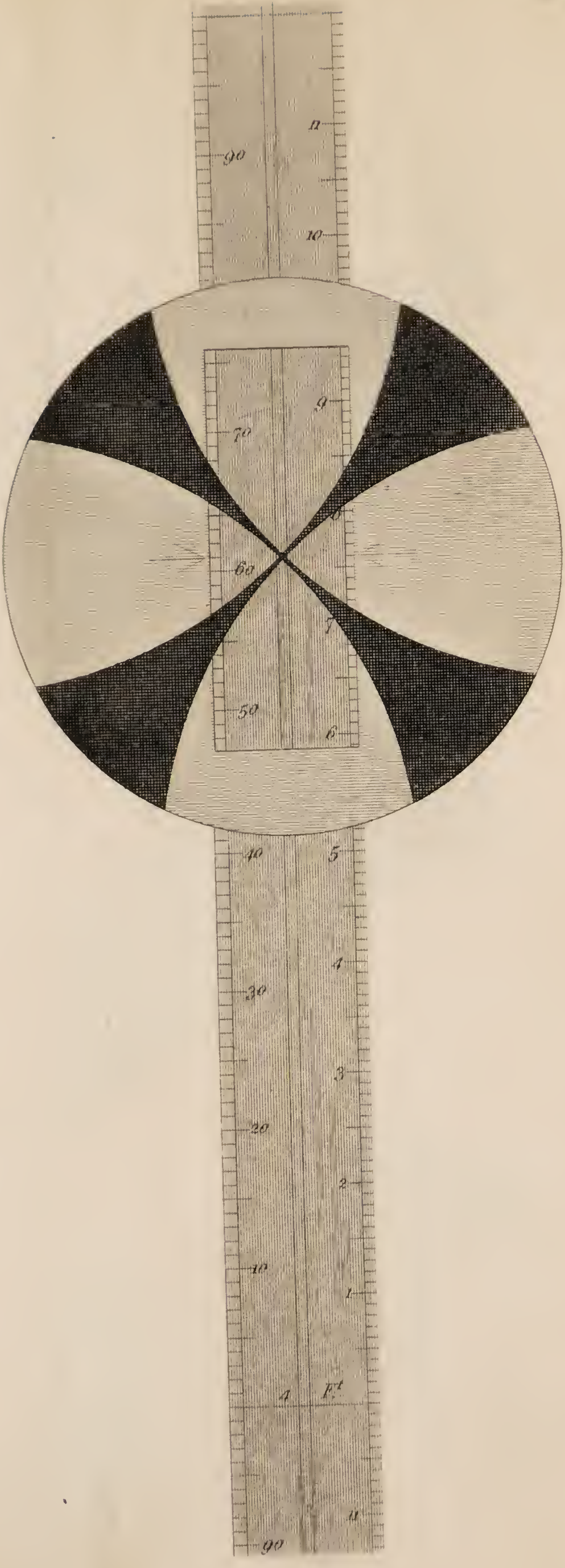
Printed by Richard Taylor and Co., Shoe Lane, London.



S. Porter sculp.

Scale of Miles

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15



J. Porter sculp.

Fig. 1.

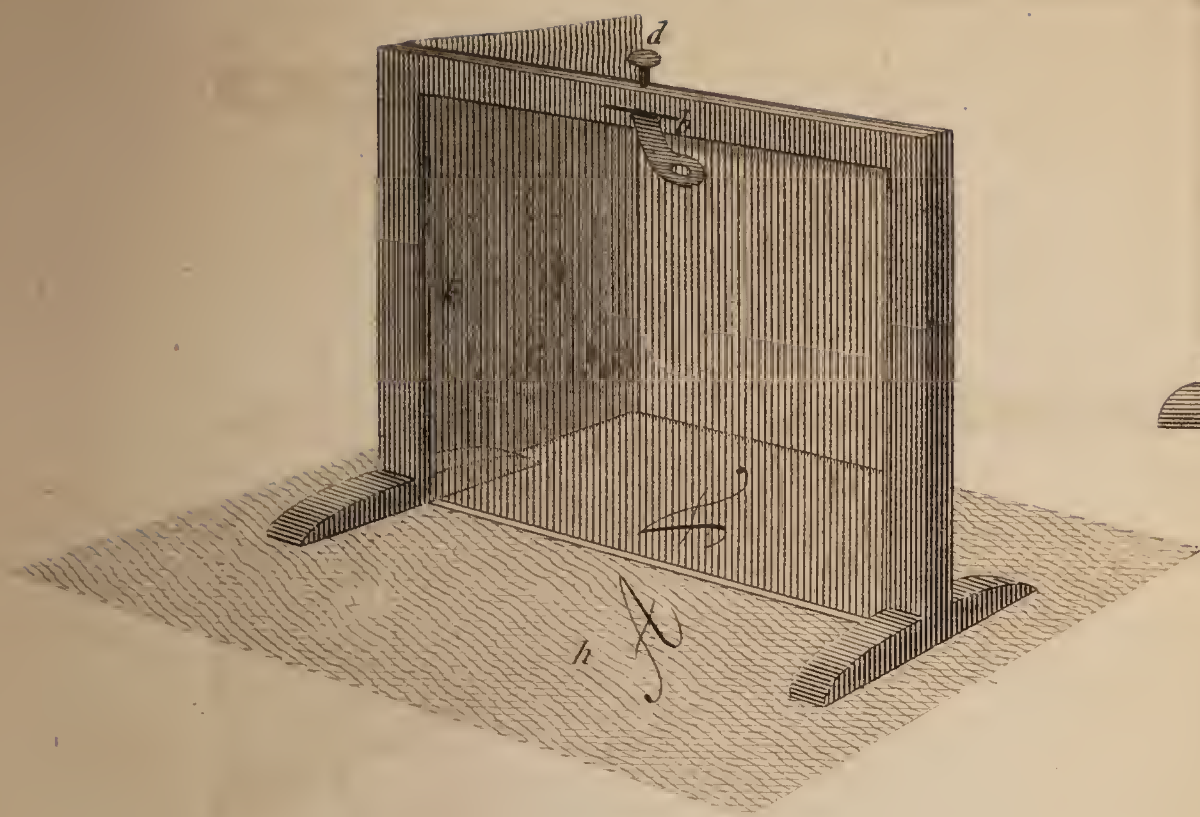
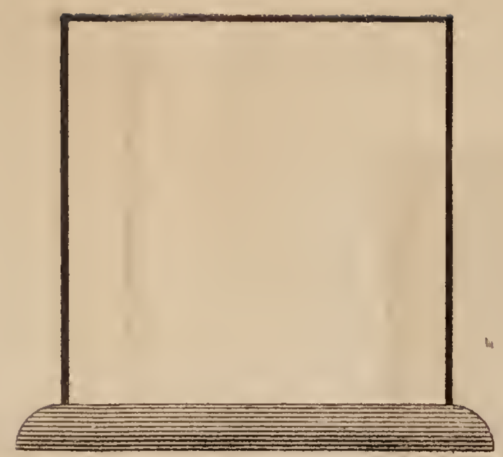


Fig. 2.



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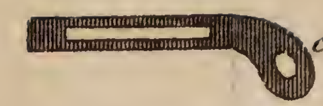


Fig. 8.

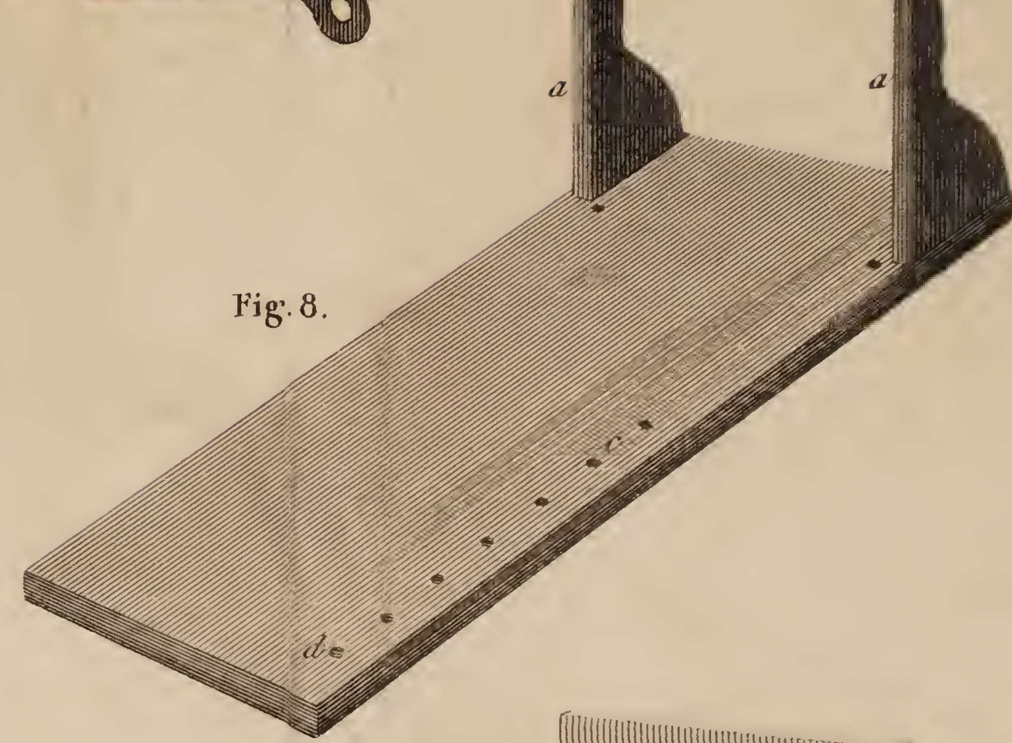
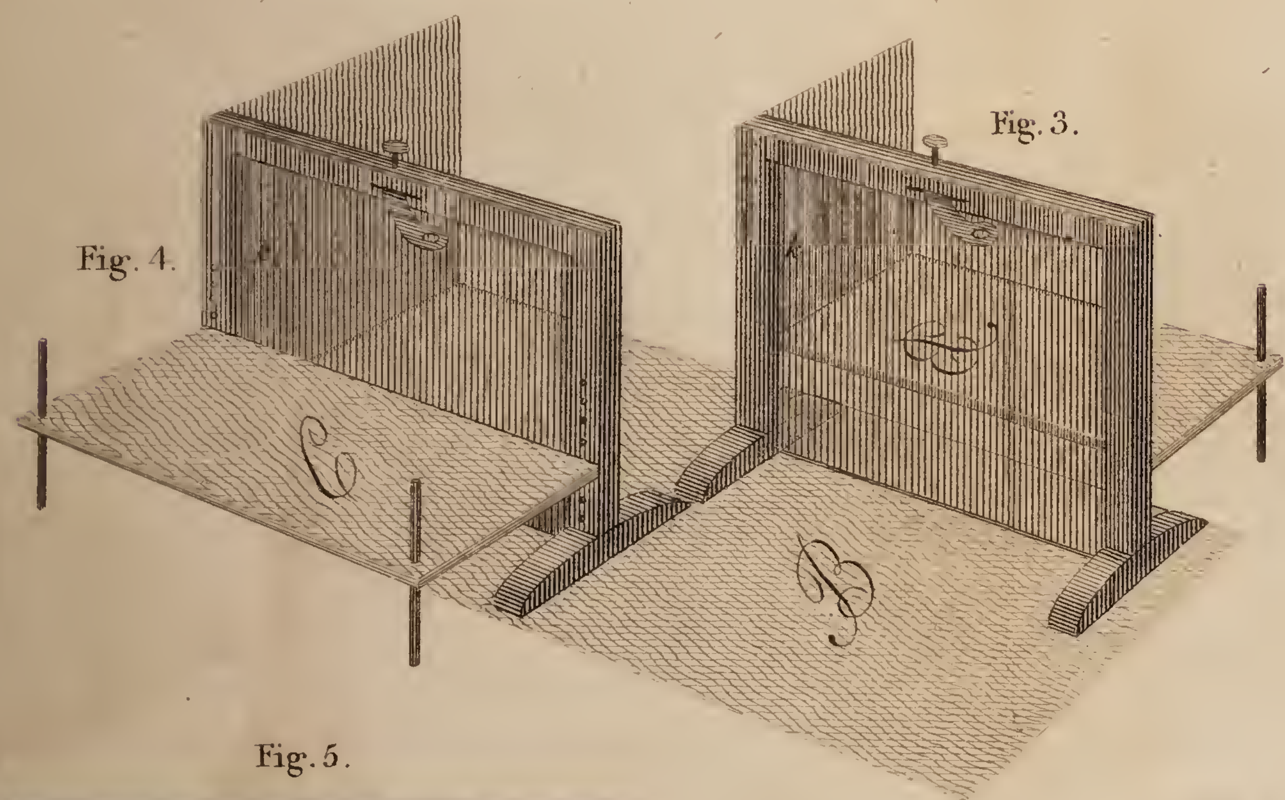


Fig. 4. Fig. 3.



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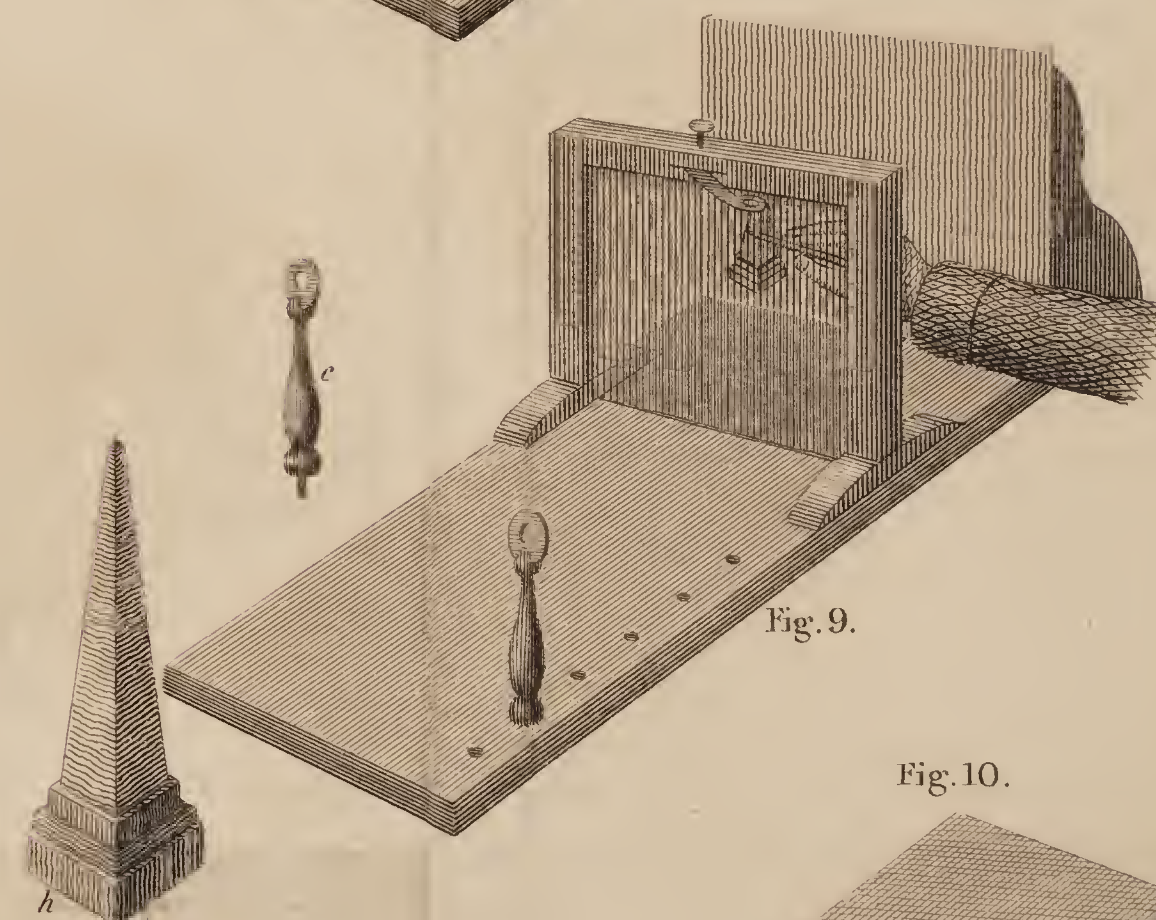

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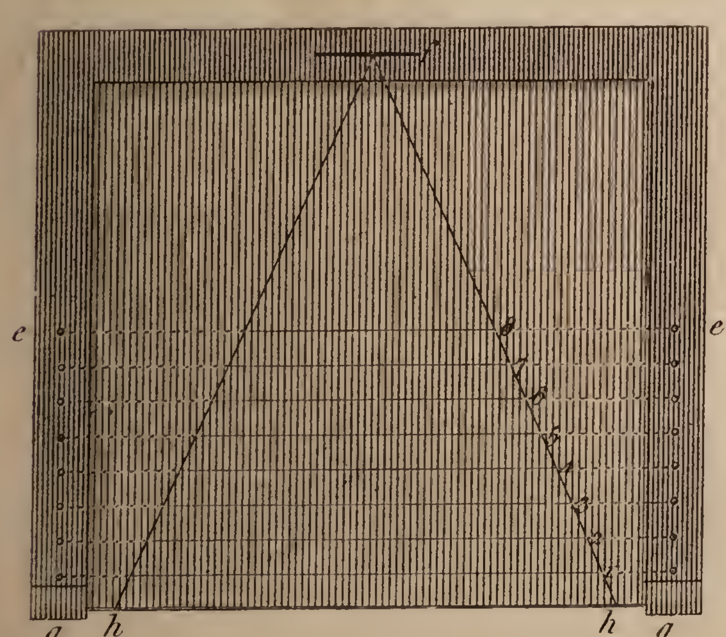


Fig. 6.

Fig. 10.

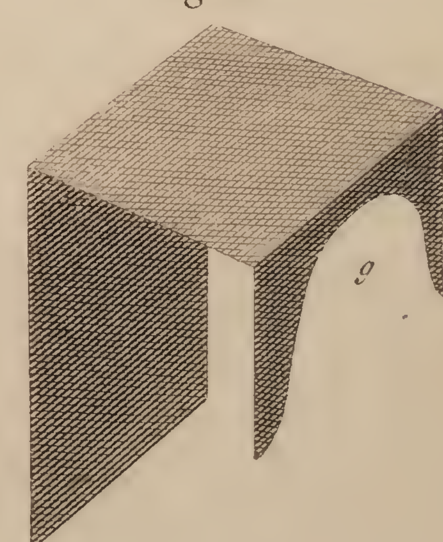
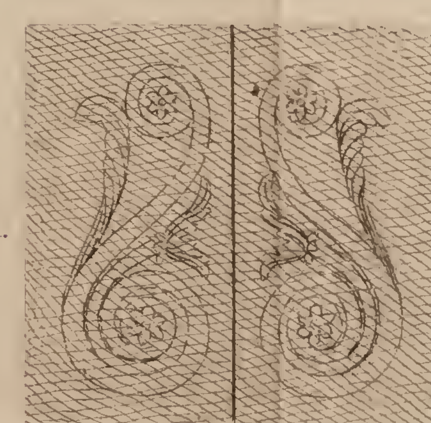
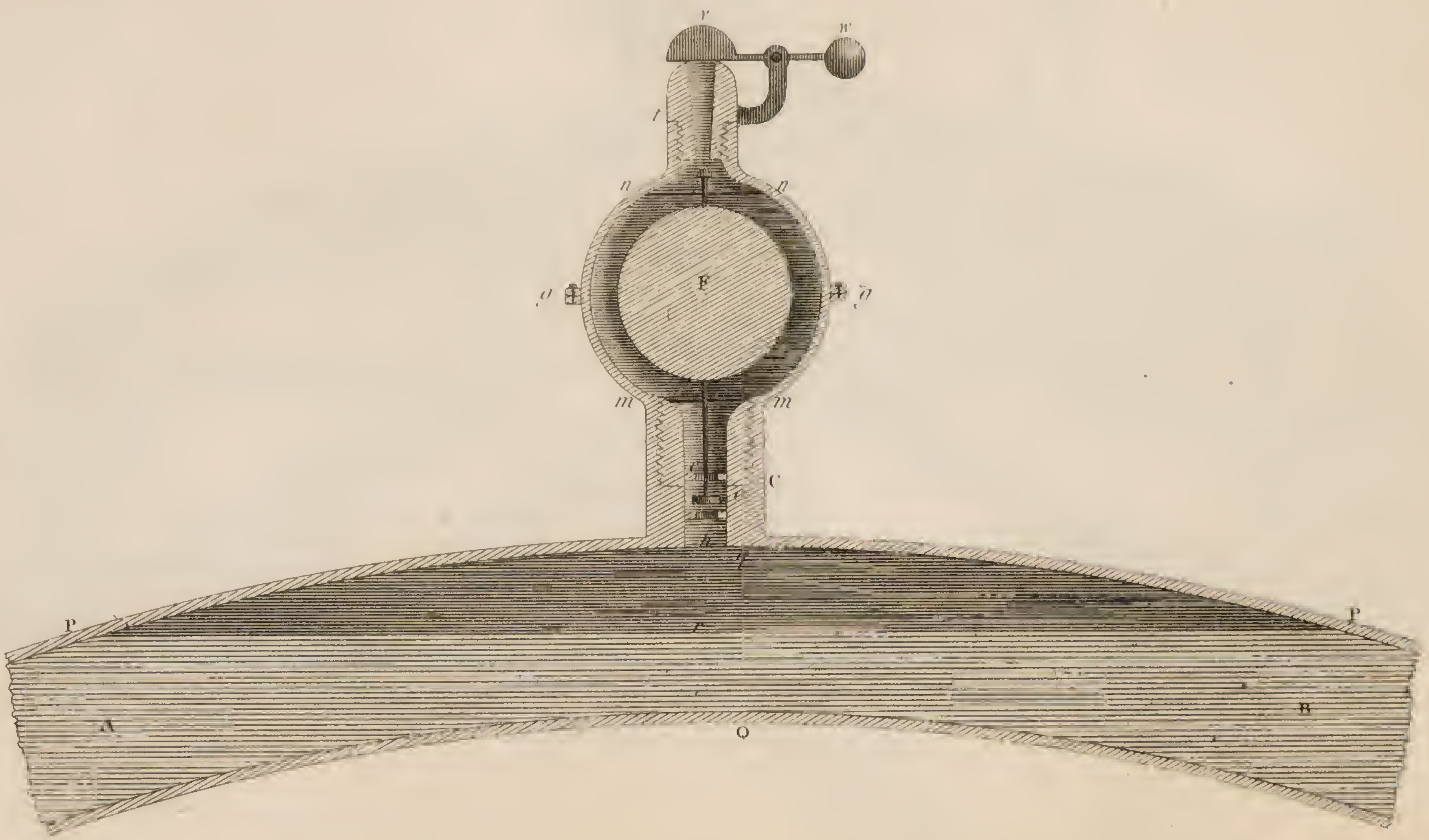


Fig. 11.



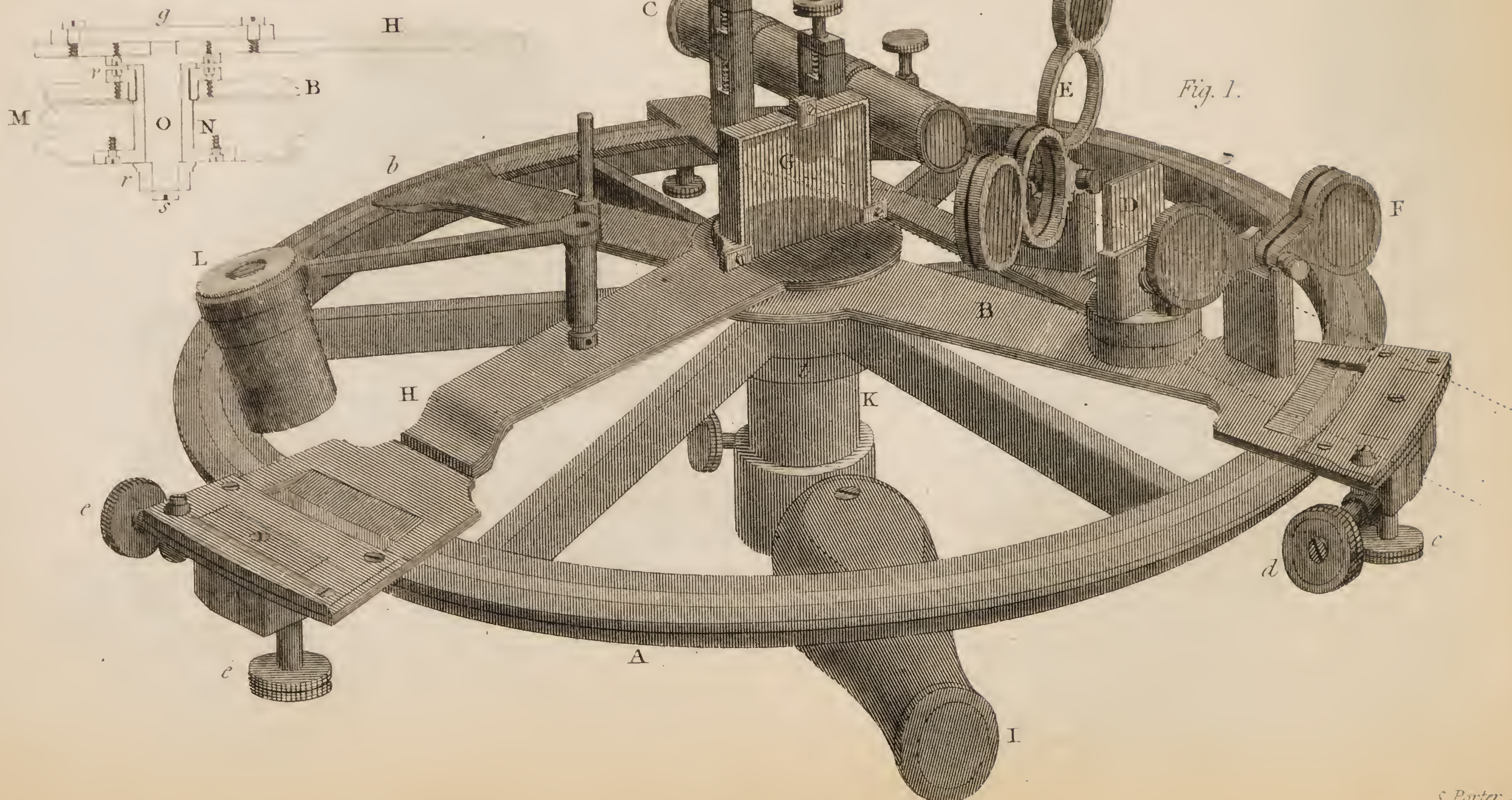
S. Porter sculp.

Apparatus for freeing Water-pipes from Air.



Mr. J. Allan's Improvement on the Reflecting Circle invented by La Borda.

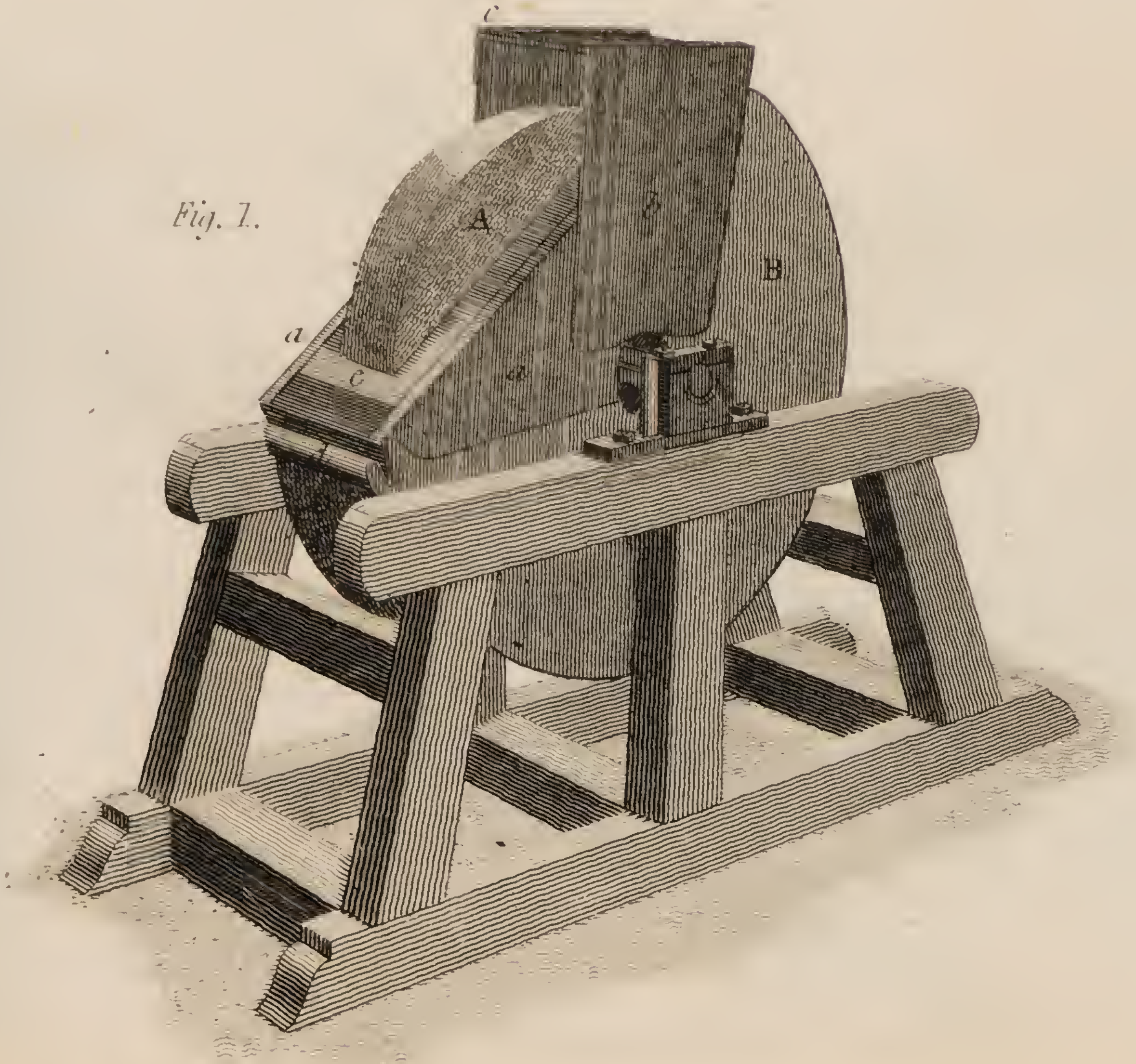
Fig. 2.



S. Porter sc.

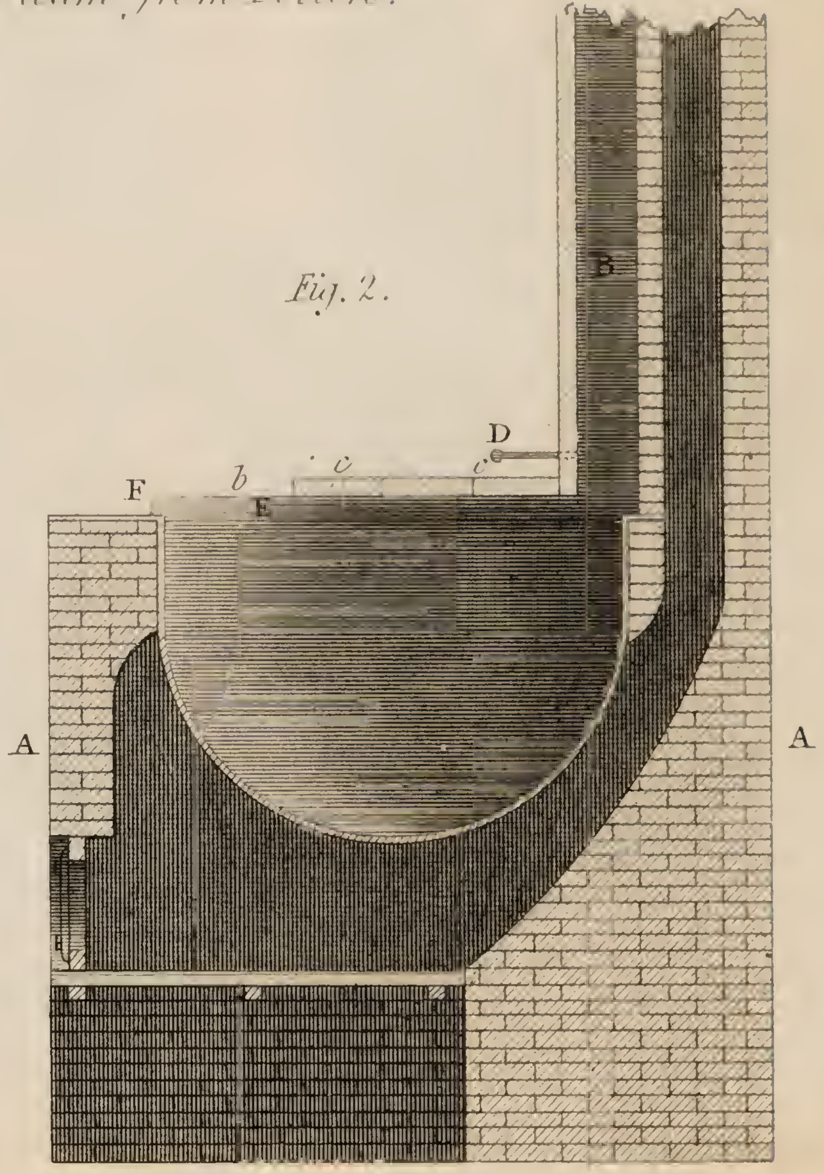
Mr. Wood's Enclosed Grindstone,
for Pointing Needles.

Fig. 1.



Mr. Webster's Method of carrying
off Steam from Boilers.

Fig. 2.



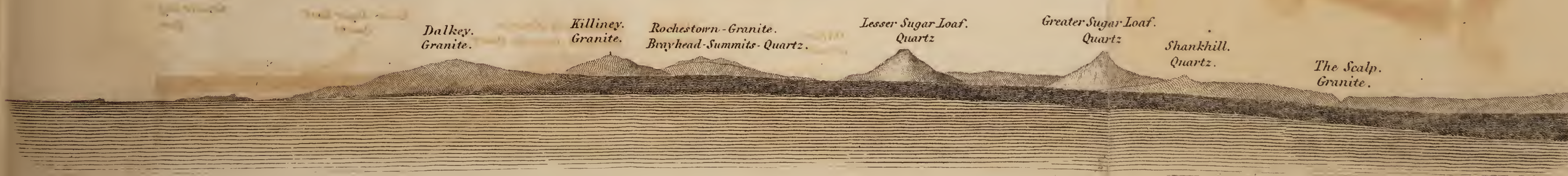
S. Porter sc.

Granite veins on the shore at Killiney.

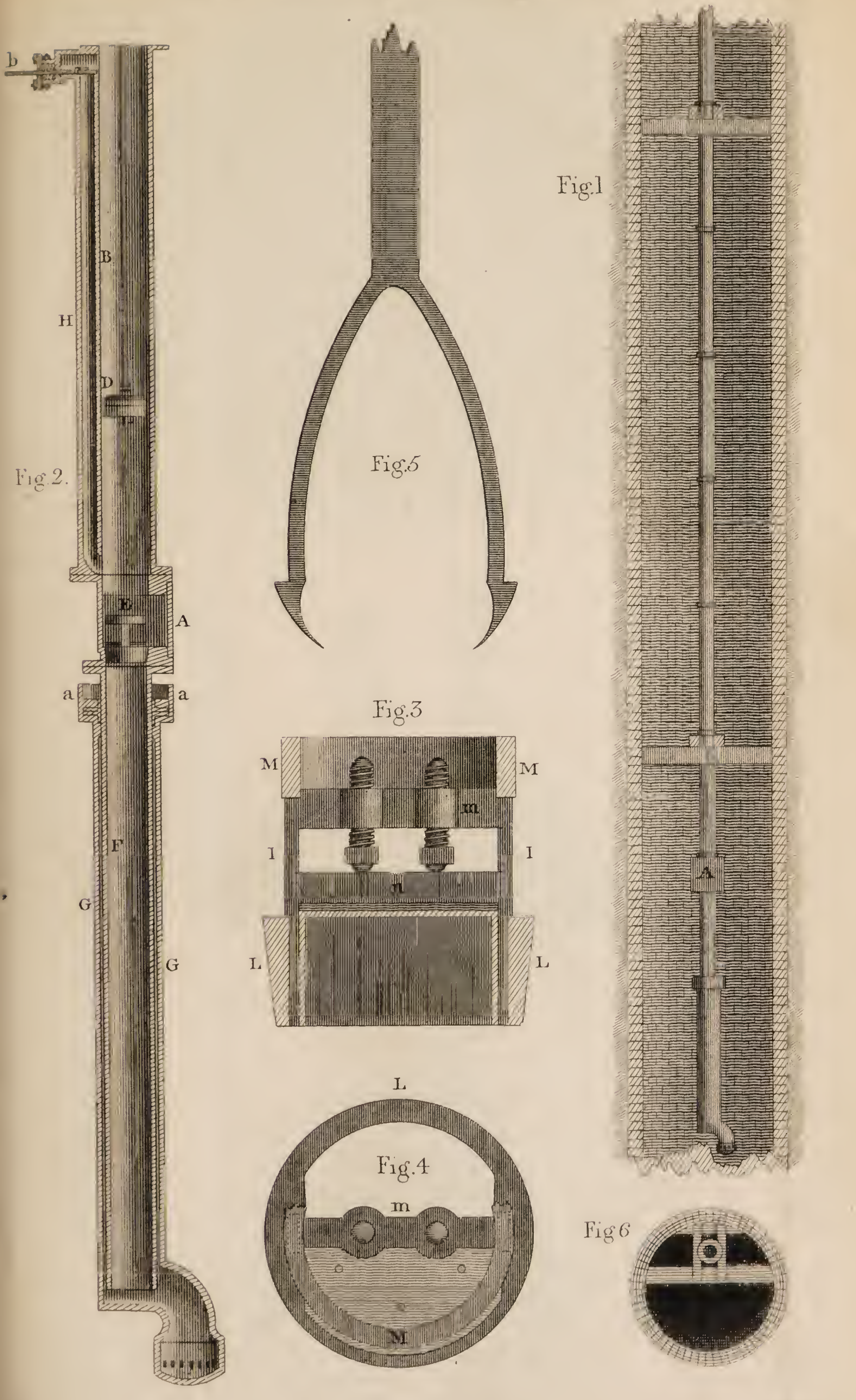
Junction of Granite & schist at Rochestown-Hill.

Hewitt sc. Queen Str. Bloomsby.

The Hills to the South of Dublin Bay _ from the Light House.



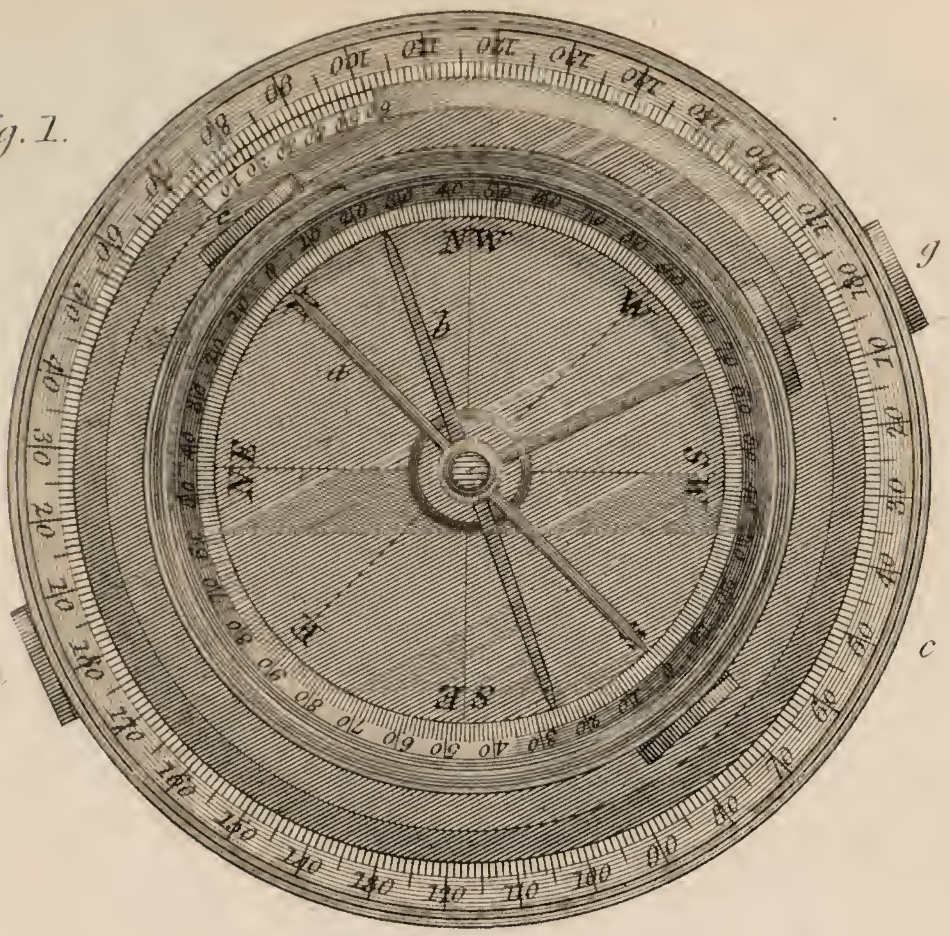
Mr. Wm. Brunton's Improved Pump for Mines.



S. Porter sc.

Mr. Hodgson's Improved Compass.

Fig. 1.



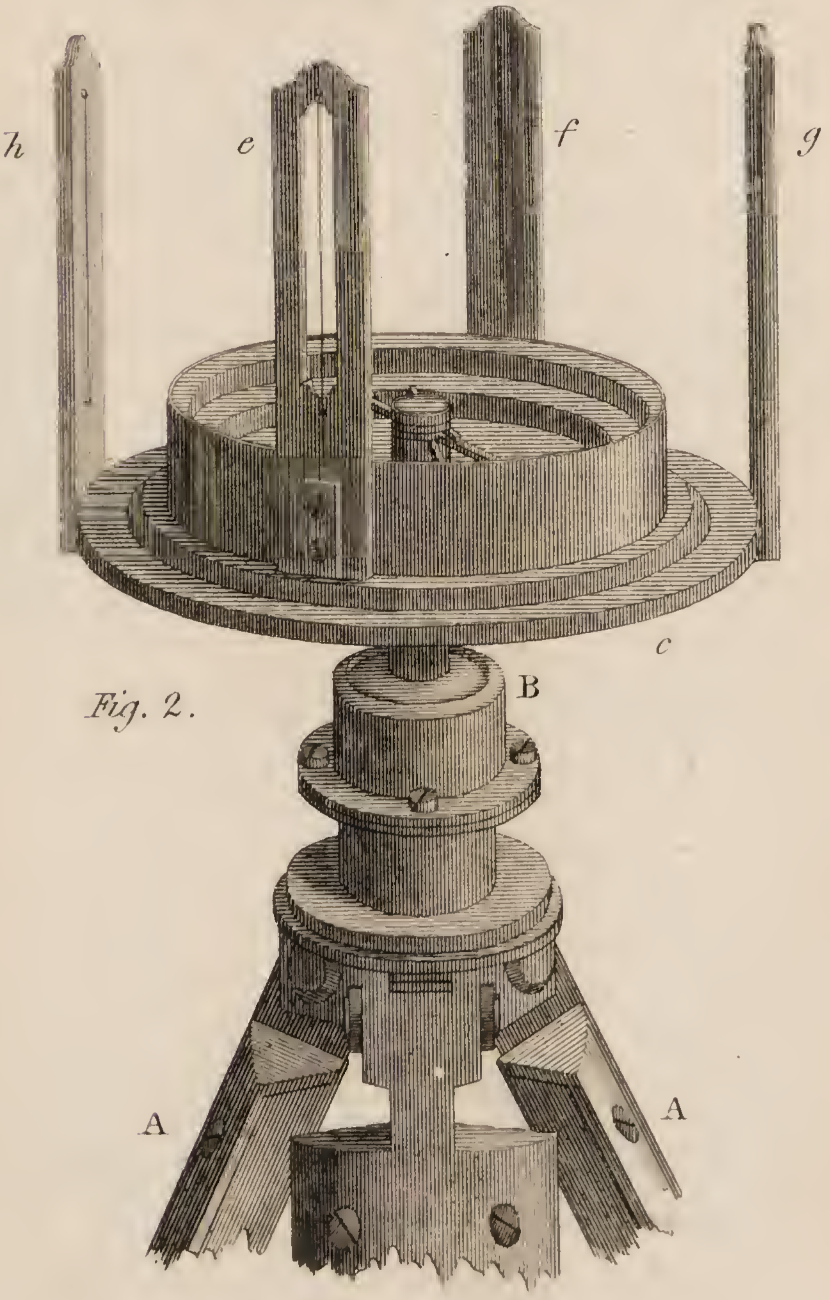


Fig. 2.